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MANHATTAN DISTRICT HISTORY

BOOK IV - PILE PROJECT

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VOLUME 5 - CONSTRUCTION

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31 December 1946

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FOREWORD

This volume of Book IV of the Manhattan District History presents a discussion of the pertinent facts relating to the construction of the Hanford Engineer Works. Project activities during the period from 19 March 1943, the start of construction, to 31 March 1945, the official date for the completion of construction activities, are covered in this volume; since there was no major construction between 31 March 1945 and 31 December 1946, no attempt has been made to include so-called minor construction activities but rather, these have been covered as a phase of operations (See Vol. 6). Wherever possible, minute detail has been avoided in order to present a clear, comprehensive history of the scope of construction activities and the problems encountered during the construction period.

Although the construction forces were charged with the responsibility for procuring the initial charge for Pile operations and for testing, identifying, and calibrating process equipment, these activities are discussed in Volume 6 since they apply directly to production operations. Detailed descriptions of the main process buildings are included with the photographs in Appendix A. A complete set of photographs of the completed plant and Richland Village is included in Volume 6, Appendix A.

The summary contains an abstract of every major subject treated in the text and is keyed to the text in such a manner that paragraph headings and numbers in the summary refer to the various sections in the main text.

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Supplementary material and references, necessary to clear understanding of the narrative, are included in five appendices. Appendix references have been made in the text as a combination of letters and numerals. Thus (See App. A 18) would refer to Appendix A, Item 18 of that Appendix.

Other phases of the history of the Pile Project are described in:

Book IV - Volume 1 — General Features

Book IV - Volume 2 — Research

Book IV - Volume 3 — Design

Book IV - Volume 4 — Land Acquisition, W.S.M.

Book IV - Volume 5 — Operation

31 December 1946

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MANHATTAN DISTRICT HISTORY

BOOK IV - PILE PROJECT

VOLUME 5 - CONSTRUCTION

TABLE OF CONTENTS

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SUMMARY

1. Introduction. - The objective of the construction of the Hanford Engineer Works was the building of a plant for the production of plutonium in the shortest possible time and in sufficient amount to provide for military requirements. The scope of work entailed construction of a permanent manufacturing plant and the attendant housing, service, and temporary facilities necessary for construction and operation of the plant. The permanent plant includes six process areas, one lag storage area, and a village. Special consideration was given to innumerable and unprecedented problems created by the magnitude of the Project, the large distances between plant units, the isolation of the site, the time element, and the requirements of high quality of

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construction and of military secrecy and security. E. I. du Pont de Nemours and Company was selected as the contractor for the design, construction, and operation of the Hanford Engineer Works, shortly after authorization of the Project by the President of the United States.

2. Construction Planning. - The location chosen for the site of the plant for large-scale production of plutonium was found very satisfactory, both from the standpoint of isolation and existence of the necessary fundamentals to the process -- the Columbia River affording a reliable source of pure cold water and the Bonneville and Coulee Dams affording a source of electrical power. In the Preliminary site development work, the water of the Columbia River was proved to contain no seriously inhibiting dissolved or suspended materials. The soil investigations indicated that the surface was capable of maintaining the

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immense loads which would be placed on it due to the massive structure of the process buildings, and that sufficient aggregate would be obtainable on the site to provide for concrete requirements. Concrete was to be the most extensively used material in the construction of the plant. It was planned to develop two principal aggregate sources on the site, and to bring all cement in by rail. The concrete was to be transported from the mixing plants to the buildings by concrete pumps and by transit-mix trucks. Specialty work was to be subcontracted whenever possible and the use of critical materials held to a minimum. Critical materials were to be used extensively, however, because of the unique requirements of the Project. The construction of an operating plant that would produce successfully with minimum possibility of failure was the ruling element in all decisions leading up to final design and construction plans. All existing transportation facilities were utilized to the greatest possible extent and it was planned to expedite construction of all additional transportation facilities needed in order to make them available for construction work in all of the process areas. These areas were to be separated by relatively large distances according to design requirements for safety and security. As the principal use of water would be concentrated in the Pile Areas, these were located nearest to the river, and it was decided that the water requirements of the Separation Areas could be supplied most economically from the Pile Areas. Power supply was planned for the utmost dependability, requiring provisions for a dual system of electric and steam operation at any critical point in the process. Housing for the operating personnel of the

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plant was to be provided in Richland Village which was sufficiently removed from the process areas to satisfy safety and security requirements. During the construction period, workers were to be housed in temporary facilities both on and off the area.

3. Procurement of Equipment and Materials. - The procurement of equipment and materials for the construction of the Hanford Engineer Works, a major problem under normal conditions, was rendered still more difficult by the magnitude of the operation, the war-induced scarcity of materials, and the initial lack of detailed design upon which to base requirements. As a result, requirement estimates were continually revised as more information relative to structural detail and construction schedules became available. The remote location of the Project, relative to the principal industrial areas of the United States, affected procurement in that it necessitated dependence, to a great extent, upon West Coast suppliers.

Procurement was accomplished by five major groups. Process equipment and specially designed items were procured by the Contractor's Wilmington Office. Materials and equipment for construction and process items designated for field procurement were obtained by the Contractor's Field Office. In this office, the Excess Materials Section screened all requisitions in order to obtain as many items as possible from Government excess stocks; the Field Expediting Group kept records of all purchase orders and was responsible for equipment delivery to meet construction schedules; and the Subcontract Section was responsible for the performance of all subcontracts placed during construction. The Hanford Area Engineer's Office contained two divisions

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which expedited and carried on procurements; these were the Control Section and the Procurement Section. The Control Section was established as a coordinating agency in connection with all procurements; it was responsible for procurement of excess materials, procurement from military and other Government Agencies, and it clarified and reviewed all priority matters relating to procurement for the Project. The Procurement Section of the Area Engineer's Office handled all orders involving materials on Treasury Procurement Schedules and such items as experience showed could be purchased by the Government with greater expedition. The Wilmington Area Engineer's Office was established to expedite process equipment design and procurement. The Washington Liaison Office's chief contribution to procurement was in expediting priorities. Purchasing was executed through the use of contracts, subcontracts, and purchase orders. Whenever possible, these were made on a competitive basis. A total of 57 Direct Contracts and 81 subcontracts were let and approximately 7200 Government purchase orders and 47,000 Prime Contractor's purchase orders were required during the construction period.

One expedient used to facilitate procurement of critical and long-time-delivery equipment and materials was the placement of orders for these items as soon as design was sufficiently completed. Orders were placed far in advance to meet anticipated demands for items such as structural and stainless steel, and arrangements were made for storing the materials until time for their use. Another expedient, in frequent use, was the division of orders for similar items among several different suppliers. Materials and equipment in vendors'

shops were subject to constant inspection, and workers were asked to produce material that would meet the close tolerance and high quality specifications set by design.

A total of 11,169 pieces of major construction equipment was gathered for use on the construction of the Hanford Engineer Works. The Area Engineer at Hanford set up an equipment section whose function was to procure from any available source the equipment requisitioned by the Prime Contractor, after approval by the Area Engineer. Inasmuch as most of the construction equipment in the country, at that time, was in the possession of the United States Government, the chief method of procurement of this equipment was through the medium of transfer from other government agencies; an alternative method of obtaining equipment was by rental from private owners. It was found necessary to rent to the subcontractors most of the equipment needed for fulfilling their contract requirements.

The large amounts of equipment and materials delivered to the Project necessitated strict control in shipping, receiving and storing. The Area Engineer's Property Division was established to check and maintain records on shipments received by the Prime Contractor. Receiving and storing of equipment and materials were performed by the Prime Contractor, who set up stores for disbursing this Government property to various jobs. As construction items were declared surplus by the Prime Contractor, and after the Operations Department had selected its needs from this surplus, lists were made and the excess was shipped to other projects and Government agencies. Equipment and materials which were worn out or useless were salvaged and sold to

private bidders.

4. Construction Labor. - The acquisition and retention of an adequate labor force to complete the construction of the Project proved to be a problem of major proportions. At recruitment program planning conferences held among representatives of the Government, the Prime Contractor, and the War Manpower Commission, it was agreed that the necessary recruitment of labor outside of the northwest region would be extended special aid by the War Manpower Commission. Recruitment operations followed a general procedure in procuring workers through the WMC, attempting to maintain at all times a balance between skilled and unskilled craftsmen. An induction program was developed, designed to keep workers in an enthusiastic mood from the time of their arrival at Pasco, Washington, until they reached Hanford camp. In order to procure a sufficient number of workers, many special recruiting procedures were instituted, which included: (1) an Incentive Plan providing for payment of employee's transportation costs; (2) special aid to subcontractors; (3) recruitment in Alaska and Canada of workers leaving United States war projects located therein; (4) union recruitment through activities of union business agents; (5) a direct hiring program which enabled the United States Employment Service to hire employees directly rather than refer them to Hanford recruiters for interview and hire. A Spanish-American recruitment program was carried on intensively in the War Manpower Commission Region 10, but was later abandoned because of unfavorable response. Recruitment results showed that 262,040 people were interviewed and of these 94,307 were hired at an average cost of $52.38 per recruit.

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In general, the supply of common and rated labor did not meet the demand and labor utilization was expedited by extending the work week, instituting a training program, and preparing estimates of craft distribution needs. Labor unions gave valuable assistance by permitting members of certain crafts to work out of their classification to insure completion of critical work where craft shortages existed. Withdrawal of men by Selective Service presented a considerable problem in maintaining an adequate working force; therefore, recruiting methods were so directed that good results were obtained in the employment of men who were draft-deferred or exempt.

During the early stages of construction it was found that the rate of labor turnover and the percentage of absenteeism were excessively high because of the lack of complete facilities at the Project. In an effort to correct these conditions, which seriously threatened to delay completion of the job, several steps were taken: (1) a Utilization Committee was formed by representatives of the War Power Commission, Army Service Forces Headquarters, and the Corps of Engineers, which investigated conditions at Hanford and made recommendations for reducing the rate of turnover; (2) a "Stay-on-the-Job Campaign" was inaugurated to sponsor various activities for the workers; (3) commercial and living facilities were provided as rapidly as possible without hindering work on construction of the plant; (4) recreational facilities were also made available, working first toward the minimum facilities that would provide activity for the greatest number of people; and (5) the workers themselves formed the Hanford Engineer Works Employees' Association for the sponsorship of recreational, educational, and enter-

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tainment activities on the Project. In general, the efforts put forth to improve employee relations at Hanford proved successful and may be credited with an important part in the enormous task of construction of the Hanford Engineer Works.

5. Temporary Construction. - Temporary construction was a significant feature on a project having the physical magnitude of the Hanford Engineer Works. The final completion of the Plant hinged directly upon the speed with which the temporary buildings could be erected and utilized by the construction forces. Before work could be started on the permanent plant, it was necessary to establish a construction administration area, a camp, construction shops, and other permanent buildings and facilities.

Investigations were made prior to the establishment of temporary construction to ascertain not only the correct arrangement of housing facilities with attendant services, but also to decide the most economical type of housing, and necessary habitable requirements for the construction workers and their families. Because of the temporary nature of the entire enterprise and necessity for the utmost speed in construction, a conventional type house was not used. Various camp plans were investigated before Hanford was chosen as the site of the main construction camp. Camp layout, the first step toward actual camp construction, was begun on 5 April 1943.

The three principal types of housing and sleeping quarters that were provided at Hanford were barracks, hutments, and trailer parking lots. Construction work began on 6 April 1943 on the first group of barrack units, and on 27 May 1944 the last group of barracks was com-

pleted. Speed in barrack construction was emphasized throughout all stages of the camp's progress. During the construction period it was found that labor was being drained away from the process areas for use on Hanford Camp; therefore, to offset this, a prefabricated type of hutment was adopted. Use of these huts eased the strain on the construction force and effectively increased the number of workers available for actual plant construction. Because of the influx of a large number of families making their homes in trailers, the building of a trailer camp at Hanford became extremely important, and on 2 August 1944 the final phase of trailer camp construction was completed. The duration of the Project warranted provision of many trailer facilities, and soon the trailer camp gave every appearance of being a modern well-planned miniature city.

Three types of facilities, commercial, recreational, and community, were constructed to feed and to provide necessities for construction workers and their families. The commercial facilities included the construction of mess halls, garages and service stations, laundry, bank, post office, combined store and bus station. Morale-building facilities soon became an urgency and provision was made for recreational facilities, such as theaters, recreation halls, bowling alleys, auditorium, gymnasium, and various outdoor facilities (such as a swimming pool). Community facilities such as schools, hospitals, churches, fire and police protection, and a library made Hanford Camp unique among construction camps.

The chief causes for delays in the construction of Hanford Camp were labor shortages and difficulties in obtaining critical materials.

Hence, whenever and wherever possible, expedients were employed to increase the tempo of camp construction and to keep pace with mounting demands for living accommodations; therefore, housing construction was given precedence over all other work in Hanford in order to rush to completion the necessary living facilities which had to be provided before permanent plant work could be started.

An auxiliary construction camp was constructed approximately midway between Richland and the Metal Fabrication and Testing Area to provide additional housing for workers in the latter area. This camp was composed entirely of barracks and afforded all facilities necessary for women and men. On 14 January 1945, however, it was felt that no need for these accommodations existed, and the entire camp was taken over by the Area Engineer to house and feed the Military Police assigned to the Project.

Because of the lack of shop facilities near the plant site, and the need to fabricate classified materials, shops were established in each area, equipped with machinery to do all types of work which normally would be performed by "job shops." Since the bulk of construction work involved was in the construction of the Pile and Separation Areas, the main shops were established at a site centrally located with respect to these areas. Other shops were segregated at various locations in order to make them more practical for a particular type of work. A graphite shop was erected at the western edge of Hanford Camp with facilities for shaping, cutting, boring, facing, and testing the graphite needed for the Pile matrix. A pipe fabrication shop was located at White Bluffs, adjacent to existing rail

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facilities, for the production of concrete pipe. Nearby was located a masonite shop for the fabrication of masonite panels used in the Pile, and a structural steel fabrication shop to fabricate steel plate sections. It was also extremely important to provide a concrete plant of vast capacity in order to obtain the quantity of concrete needed. Five such independent concrete plants were established because of the wide separation of the plant areas.

Prior to the layout and construction of permanent, access, and intra-area roads to the Pile and Separation Areas, temporary roads had to be provided for the transportation of workers and construction materials to and within the respective areas, and temporary walks had to be provided to construction and camp areas to safeguard pedestrian traffic. Railroad tracks were installed to provide facilities for transporting the large amount of bulk materials and heavy equipment used in construction.

Since existing water supply facilities were not sufficient to furnish all water for construction purposes, numerous wells had to be drilled throughout the area and the Columbia River had to be relied upon for additional supply. Construction power was obtained by tapping the existing 66-kilovolt transmission lines.

At the start of construction and even after the completion of the Hanford Camp facilities, it was necessary to provide many of the workers with over-night living quarters near and in the city of Pasco. Many of the houses on the Hanford site at the time it was acquired by the Government were rehabilitated for family use, bachelor quarters, and for field offices and storage warehouses. A number of temporary

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buildings and facilities were constructed outside of specific areas, which contributed to the construction of the entire Project. An airport was originally constructed at Hanford to serve as an emergency airport for the smaller type aircraft assigned to the Area Engineer for the Project. Later, an airport of sufficient size to accommodate aircraft used by the Air Transport Command was constructed approximately one mile west of Hanford.

6. Construction of the Operating Plant. - Construction operations were begun in March of 1943, with work proceeding in all areas simultaneously. Construction was completed in March 1945.

The Metal Fabrication and Testing Area is composed of a total of 41 permanent buildings and 19 facilities. Layout work for this area was started in April 1943. Since many of the buildings in this area were to operate independently, sequence of start-ups was not interconnected and completion dates were set for each individual building rather than for the area as a whole. Construction progress was relatively slow at first because of continually changing design. The priorities of other process areas with respect to labor and materials added to the difficulties encountered in construction. Experimentation, both on the site and at other points in the United States, resulted in numerous changes to buildings and equipment during the construction period. This situation was alleviated by general expedients in the use of labor, design, and material procurement, and the ultimate schedule requirements were met.

Three Pile Areas (100-B, 100-D and 100-F) contain a total of 35, 34, and 32 permanent buildings and 32, 29, and 28 facilities, respec-

tively. Construction in the Pile Areas was the most urgent, and the greatest efforts of scheduling and expediting were directed toward them. Layout for the Pile Areas was begun on 12 March 1943. Completion dates were requested for the Pile (105-B) Building, the Pile (105-D) Building, and the Pile (105-F) Building in the order given. Since the Pile Building was the controlling factor in each of the Pile Areas, the dates requested applied to the areas as a whole. Although the B-Pile Area was completed late, the D- and F-Pile Area completion dates were maintained. Construction of the Piles required development of many new techniques since the materials used and the tolerances required were seldom encountered in the ordinary industrial construction. Each Pile consisted of an interior mass of graphite, surrounded by radiation shielding consisting of cast-iron blocks and laminated walls of steel and masonite. A number of holes are provided in the graphite mass; 2004 holes from front to rear for cooling tubes, 29 vertical holes for safety rods, and 9 horizontal holes from left to right for control rods. In addition to the work involved in the erection of the Piles, there was considerable field fabrication work required on the graphite blocks and the laminated Pile shielding. In addition to difficulties such as the shortage of skilled labor (as amplified in the Pile Areas by the fact that the average worker in the various crafts was not sufficiently skilled for work on the process units), the scarcity of some required materials, design changes, and restricted area work, problems were presented in (1) the close tolerances required in so massive a construction, (2) the cleanliness necessary in the vicinity of the Pile during construction, and (3) the

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fact that the working space in the Pile Buildings greatly restricted the number of men who could work on Pile erection at one time. Many of the difficulties were overcome by design representation in the field, assuring prompt handling of problems arising during construction by the use of shift-work and extended work periods and by the subcontracting of labor and equipment where practicable.

Three Separation Areas (S00-W, S00-E, and S00-S) contain a total of 21, 14, and 8 permanent buildings and 62, 44, and 16 service facilities, respectively. Construction of these Areas was second to the Pile Areas in importance. Preliminary work was begun in these areas on 27 March 1943. Completion forecast schedules were drawn up, based upon a combination of the preliminary design schedule, meager procurement information, and an estimate of the time required for building construction and equipment installation. These schedules were revised as the work progressed, on the basis of available labor and delivery dates of critical materials and equipment. Although early progress was slow, it improved sufficiently so that the over-all schedule for the Separation Areas was met. Although the procurement of certain materials (such as stainless steel through-concrete piping, cast-iron cell and trench forms, and stainless steel tanks,) presented the greatest problems, the difficulties were generally of the same nature as those encountered in the other areas. Subcontracts, premium payments, air and express shipments, and early placing of blanket orders were means by which delivery of critical materials was expedited. It was recognized that special construction methods and sequences would have to be adopted and followed in building construction in order for pro-

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cision workmanship and speed to be attained. Field fabrication and production line pre-assembly of cell equipment were necessary in order to utilize latest design details and maintain construction schedules. As in the cases of the other process areas, permanent building construction consisted of reinforced concrete, structural steel framing, concrete block, and wood frame construction.

7. Construction of Service Facilities. - Electrical power was purchased from the Bonneville Power Administration and was fed from the Grand Coulee and Bonneville Hydro-Electric Plants. Power for the Metal Fabrication and Testing Area and Richland Village is obtained from a Bonneville Power Administration tie-line to two substations of the Pacific Power and Light Company through which delivery to the Project is made. The Pile and Separation Areas are served by a 230-kilovolt loop system from which the voltage is reduced at substations for various plant uses. The Project transmission system consists primarily of 230-, 115-, 60-, 13.8-, and 2.3-kilovolt lines.

The installation of telephone cable and instruments was handled by the Signal Corps Division of the Ninth Service Command, which directed the Pacific Telephone and Telegraph Company in most of the permanent telephone construction. It was decided that none of the five independent companies on the Site had sufficient experience, technical ability, and equipment to establish and maintain the telephone system required for the Project, and their property, which will be returned when the site is vacated, was acquired by the Government. Sufficient Western Union printers and teletypewriter circuits were established to maintain contact with various phases of the Manhattan District Pro-

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ject and other necessary points of communication. Because of the area involved and the widely separated locations of the plants, it was considered essential to equip isolated patrol stations, patrol cars, and patrol planes with two-way radio communication. The majority of communications equipment necessary to fulfill requirements was requisitioned from the Signal Corps.

Since the existing road and railroad facilities were insufficient to handle the heavy traffic demands of the Project, new facilities, as well as improvements in the old, were needed. Preliminary surveys for road and inter-area railroad layouts were made by profile and cross section method over routes suggested by the Wilmington Design Division. The alignment of existing plant roads and railroads was used, whenever possible, to reduce the amount of grading. The Prime Contractor assumed responsibility for maintenance of the majority of roads and railroads on the Project and subcontracted the actual construction work. At the beginning of the construction period, a certain amount of work had to be performed immediately to handle safely and efficiently the increasing volume of plant traffic. Plant access roads and main thoroughfares were reshaped and widened. Since rail transportation direct to the working areas would minimize the rehandling of construction material and equipment, immediate steps were taken to put existing tracks of the Chicago, Milwaukee, St. Paul and Pacific Railroad in condition for the heavy service anticipated. A thorough job was performed in the construction of permanent roads in order that they could support the large volume of traffic in all types of weather. Rock excavation, grading, and sand and gravel fills were among the tasks

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of railroad construction. Definite sequence schedules were established and followed in the construction of all roads, and the work covered in the original road contract was essentially complete by the middle of December 1943.

8. Richland Village. - Because the Prime Contractor's Design Division was actively engaged in work on the process areas of the Hanford Engineer Works and other war plants, the design and construction of Richland Village was subcontracted to firms familiar with that type of work. Because the Richland coordinate system was established before the plant system was complete, no attempt was made to tie the village into the plant system. Layout work for Richland was begun on 20 March 1943. Although hampered by design changes brought about by population estimate revisions, by labor shortages, and by the necessity of saving all existing facilities and buildings which would be of benefit in the new village, a town to accommodate approximately 17,500 persons was constructed in less than two years. One of the expedients used in the construction of Richland Village was the installation of prefabricated houses, which were hauled to the Project in sections, placed on foundations, fastened together, and then anchored.

The Administration Area was constructed within the limits of Richland Village. Construction of this area was performed under subcontract inasmuch as it was constructed concurrently with, and as a part of, the village. Since the Administration Area contains no process buildings, it was not included in the over-all Project schedule. Design changes, which eventually resulted in doubling the number of

buildings originally planned for this area, were the major difficulties encountered in construction.

9. Transportation. - Provisions for the large scale transportation of equipment, materials, and personnel included improvements to existing facilities as well as the establishment of a number of new facilities. Railroad use was confined to freight movements; the magnitude of these operations is illustrated by the fact that 40,000 carloads of material were shipped into the Project during the construction period. A few commodities, such as oil and gasoline, were received by boat or barge. Items of equipment which required special attention in order to avoid construction delays were delivered to Hanford by the Air Transport Service. A bus system was established to provide for the transportation of workmen to and from their jobs. A total of 904 buses carried approximately 20 million passengers during the construction period. The Area Engineer's Transportation Department maintained, scheduled, dispatched, and operated most of the Project's transportation equipment.

10. Safety. - The safety program for the Hanford Engineer Works was considered an essential part of the program for the successful completion of the Project in that it enabled the maximum use of available manpower, improved employee morale, reduced labor turnover and absenteeism, and, because of a good reputation for preventing accidents, assisted in the recruitment of personnel. The Area Engineer's Safety Division was established to function without direct supervision by the Manhattan District. It was staffed by qualified personnel, who supervised the Prime Contractor's safety program, and was organized

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into four sections to cope with the safety problems inherent in construction, traffic control, community safety, and fire protection and prevention. Safety education was promoted by meetings, literature and statistics, contests, and expositions. An important factor in the working of the safety program was the use of safety equipment such as gloves, shoes, goggles, and coveralls. Special consideration was given to the question of the women employees on the Project, and a female safety engineer was employed to analyse and organise the work in this respect. That the safety program was effective is shown by comparative statistics between the Hanford Engineer Works and industry throughout the United States; these indicate that this Project had a better record in all respects.

11. Cost. - The construction cost included the cost of all materials necessary to equip the plant for the start-up of manufacturing operations. Cost records were maintained by the Prime Contractor, with certain modifications of his regular accounting method in order to comply with general accounting methods of the Corps of Engineers. Labor charges and main subcontract-labor charges were allocated on a time card basis. Materials and equipment and main subcontractors' material and equipment were allocated on the basis of store tickets. The cost of major construction equipment maintenance was distributed periodically, on the basis of total labor charges, to the construction feature accounts during the period involved; overhead and deferred accounts were distributed by a similar method. The total cost of construction, $348,101,240, includes $253,517,191 for main plant construction; $43,674,392 for Richland Village construc-

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tion; and $50,909,657 for special construction features.

12. Personnel and Organization. - The Hanford Engineer Works Construction Organization was composed of two branches; one reporting to the Area Engineer, representing the Manhattan District; the other reporting to a Field Project Manager, representing the Prime Contractor. The Area Engineer's Office, headed by Colonel F. T. Matthias, acted in a supervisory and reviewing capacity and did not actually perform construction activities. This office consisted of two divisions: Construction, which had to do with prosecution of field construction; and Services, which had to do with the services necessary to furnish the needs of field construction. The Contractor's organization, which performed all actual construction work, was headed by a Field Project Manager, G. P. Church, who was assisted by six assistant field managers responsible for various engineering and administrative divisions. In addition, there were four divisions, Audit, Accounting, Design, and Traffic, reporting directly to the du Pont Wilmington Office.

MANHATTAN DISTRICT HISTORY

BOOK IV - PILE PROJECT

VOLUME 5 - CONSTRUCTION

SECTION 1 - INTRODUCTION

1-1. Objectives. - The primary objective of the construction of the Hanford Engineer Works was the building and equipping of a plant for the manufacture of plutonium in adequate quantities, and in time, to meet military requirements; a secondary objective was the accomplishment of the work at the lowest cost commensurate with attainment of the primary objectives.

1-2. Scope. - The undertaking entailed the construction of major manufacturing areas with auxiliary and service facilities; a village to provide for the essential living requirements of operating personnel, including facilities for the main administrative headquarters and nonhazardous services common to the several manufacturing areas; and all temporary facilities necessary for the construction of a permanent plant to produce quantities of plutonium in accordance with the engineering design described in Volume 3.

1-3. Authorization.

a. General. - See Volume 1, paragraph 1-3, page 1.2.

b. Specific. - The original specific authorization for the construction of the Hanford Engineer Works is found in a report of 13 June 1942 signed by Dr. J. B. Conant, Chairman NDRC, and Dr. V. Bush, Director OSRD, and approved by the Chief of Staff, the Secretary of War, and the Vice President of the United States. The report was

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transmitted by letter, dated 17 June 1942, from Dr. Bush to the President, who approved it.

1-4. Construction Contractor and Authorizations. - E. I. du Pont de Nemours and Company was selected as the Prime Contractor for the design, construction, and operation of the Hanford Engineer Works on the basis of previous successful industrial experience most nearly conforming to the rigid requirements of the Project (See Vol. 1). The Prime Contract, W-7412 eng-1 (See App. C 1), between the Government and du Pont constituted the basis and authorization for performing the work. Authorization for structural work on individual elements of the permanent manufacturing facilities was made by the signature of the Area Engineer at Wilmington, Delaware, based on design drawings submitted by the Design Division of the Prime Contractor (See App. C 2), after review and recommendation by consultants attached to the Office of the Area Engineer (See Vol. 3). Authority was delegated to the Area Engineer at Wilmington by letter from the District Engineer (See App. C 3). All work on process facilities was subject to approval by the Area Engineer at Chicago, Illinois, prior to authorization by the Area Engineer at Wilmington. All construction work for the operating village (Richland) and temporary construction facilities was authorized by the Area Engineer at Hanford through authority delegated by letter from the District Engineer (See App. C 4).

1-5. General Description. - The permanent plant, as completed, includes seven process areas and Richland Village (See App. A 1, 2). The process areas include one Metal Fabrication and Testing Area,

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three Pile Areas, and three Separation Areas (one of which is used for lag storage only).

a. Process Areas.

(1) Metal Fabrication and Testing Area. - This area contains manufacturing facilities for fabricating metallic uranium billets into individual pieces called slugs; for bonding and hermetically sealing the slugs in aluminum cans; and for testing the canned slugs exhaustively to reduce to a minimum the possibility of a failure within the Piles. A Test Pile is located in this area for determining the neutron emitting and absorbing characteristics of all materials placed in the manufacturing Piles. Laboratories and shops are provided for those aspects of plant work common to several areas or involving relatively minor radioactive hazards. Auxiliaries include a water system, steam and electric power, and maintenance and administrative facilities (See Volume 3, page 3.2).

(2) Pile Areas. - Each Pile Area contains a 250,000-kilowatt Pile for manufacturing plutonium, designed and constructed to dissipate this heat equivalent through the medium of water; to confine safely the intense radioactivity associated with the process; and to permit charging, discharging, and handling of the canned uranium slugs. Each Pile Area also contains elaborate water pumping, storing, conditioning, and distributing systems to meet its own requirements, the emergency requirements of the other Pile Areas, and, through interconnecting piping, the requirements of the Separation Areas. Auxiliaries include steam and electric power, and laboratory, shop, maintenance, and administrative facilities (See Volume 3, page

3.2).

(3) Separation Areas. - There are three Separation Plants, two in the West Separation Area and one in the East Separation Area. Each Separation Plant includes a Separation and a Concentration Building, a tank farm for storage of liquid chemicals, a Chemical Preparation and Storage Building, a Control Laboratory, a ventilation system and stack, and Waste Disposal Tanks for storage of processed uranium and highly radioactive wastes. The East Separation Area, originally planned to duplicate the facilities of the West Area, was later modified to provide for only one Separation Plant; however, the waste disposal facilities for the abandoned plant were constructed. The intense radioactivity associated with the process demanded that design and construction be such that the majority of the process steps could be accomplished behind massive concrete shielding by highly developed methods of remote control, operation, and maintenance. The three Separation Plants are served by a single Isolation Building located in the West Separation Area where final processing of the plutonium is accomplished and where the material is loaded into special cans in preparation for shipment. Auxiliaries include steam generation, electric power, water systems, laundry for contaminated clothing, shop, maintenance, and administrative facilities. The North Separation (Lag Storage) Area contains three buildings which provide storage for the Pile metal in transit from the Pile to the Separation Areas. The Magazine Storage (218) Building, considered part of the North Separation Area for construction purposes, provides storage facilities for the product (See Vol. 3, page 3.3).

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b. Richland Village. - Richland Village provides housing, service, and commercial facilities for operations personnel. It is located at a safe distance from the manufacturing areas in the southeast corner of the Project site (See App. A 2; B 1). The Administration Area, consisting of administrative and service buildings serving the entire plant, is located in the heart of the village.

1-6. Special Considerations. - The construction of the Hanford Engineer Works presented innumerable and unprecedented problems which were successfully overcome in the prosecution of the work. These problems stemmed from several basic requirements established by process research and development, engineering design, and policy. The principal factors which created these problems are enumerated as follows:

1. The magnitude of the Project.
2. The large distance between the several manufacturing plants to be constructed.
3. The isolated location of the site.
4. The time element which demanded that construction proceed without awaiting completion of engineering design.
5. The unusually high quality of construction and rigid adherence to small tolerances required in many instances.
6. The extreme and rigid requirements of military secrecy and security.

Each of these factors is discussed briefly in the following paragraphs:

a. Magnitude. - The following typical total construction

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quantities are approximate and selected at random to indicate the magnitude of the projects:

Excavation	28-million cubic yards
Water Pumping	366,000 gallons per minute from river
Concrete	780,000 cubic yards
Structural Steel	40,000 tons
Lumber	160-million board feet
Major Construction Equipment	11,188 pieces
Railroad Track	198 miles
Roadway	328 miles
Steel Pipe	250 miles
Construction Material	40,000 carloads
Manufacturing & Service Buildings	564 units
Peak Employment (Totals for all contractor and government forces.)	48,000 persons

b. Distances. - The necessity for separating the several areas by relatively great distances from each other and from inhabited areas imposed abnormal problems for transportation of men and materials. A large majority of the construction personnel lived at Hanford Camp, a distance of eight to twenty miles from the operating areas (See App. B 1). These distances are further emphasized by the fact that 340,000,000 passenger-miles of bus transportation were furnished during the construction phase of the work. This is approximately equivalent to the transportation of 110,000 persons across the United States.

c. Isolation of Site. - The isolation of the site from

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any existing centers of population (See App. B 2) presented serious problems with respect to many phases of construction. These problems were related primarily to the procurement, transportation, housing, feeding, health, morale, and retention of a maximum total construction force of about 48,000 persons (totals for all contractor forces plus government personnel), which number was reached in June 1944.

d. Time Element. - The urgent need for placing the plant in operation at the earliest possible date forced initiation of construction work when only meager design data were available. In many instances, construction work was in progress on some essential elements even before complete basic research had been fully developed. Consequently, the burden of construction planning, scheduling, and procurement was extremely great; nevertheless, the final completion of the job was advanced beyond reasonable expectations.

e. Quality of Construction. - The quality of construction demanded by the rigid requirements of the manufacturing processes was unusually high (See Vol. 3). This was particularly true of the Pile and Separation Areas. The problem of procuring an adequate number of craftsmen sufficiently skilled to perform the work was one of the most critical encountered and necessitated a special training program.

f. Military Secrecy and Security. - The essential and rigid requirements of military secrecy imposed serious problems (See Vol. 1). Investigations had to be prosecuted vigorously to avoid delay in employment and utilization of personnel on work and in areas that were classified. Key employees and supervisors could not

be given a complete over-all picture of the Project, but a high degree of coordination and direction of performance by top supervision was effective in avoiding delay and confusion that might have been imposed by the necessary limitations of security. Protection was provided by a patrol and guard force and by a pass and badge system that insured admittance of authorized personnel only to certain working areas.

SECTION 2 - CONSTRUCTION PLANNING

2-1. General. - Reference is made to Volume 3 for the basis for the selection of the Hanford area as the site of the large-scale plant, and for the process requirements for large quantities of pure, cold water and an unusually reliable source of large quantities of electrical power. For plant security and for protection of individuals in the neighboring communities against both known and unknown hazards associated with the process, a site isolated from any large centers of population, public roads, or main line railroads, and yet large enough to permit separation of individual operating units to satisfy safety requirements, had been chosen. This site, located on the Columbia River, afforded a good source of pure, cold water for plant use as well as electrical power generated at the Bonneville and Grand Coulee Dams.

2-2. Site Development.

a. Soil Exploration. - Early in January 1943, when it seemed obvious that the Hanford Site was the most desirable, arrangements were made for the Seattle District Engineer to perform immediate subsurface exploration to determine the character of the subsoil, bearing capacity of the soil, and the location of ground water and bedrock surface. It was known that the structures would be very large and heavy, and would require high foundation-bearing capacity, possibly up to four to six tons per square foot. It was decided that seismographic exploration work would give the essential information most rapidly, and work was started at numerous points throughout the

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area. A few of these points were checked by actual drilling, thereby allowing a comparison of the record log of drilling with comparable information as disclosed by the seismographic recording and permitting a more accurate interpretation of the recordings. Test pits were dug through the surface soil and bearing capacity tests were made. All information developed by the Seattle District Engineer was reported frequently to the Contractor to contribute to the basic design information and basic design standards (See App. C 5).

b. Water. - Very small concentrations of certain types of minerals frequently occurring in natural water would be sufficiently inhibiting to the basic reactions to prevent the functioning of the process. This fact necessitated chemical analysis of the water before a definite commitment could be made as to the site. Chemical analyses of the river water obtained from points above Hanford indicated that there were no seriously inhibiting materials dissolved or suspended in the water (See App. C 6).

2-3. Construction Materials.

a. Concrete. - It was recognized early in the design period that the buildings would have to be of massive concrete construction, not so much for the strength of the structures as for protection of personnel from radioactive emissions during operations.

(1) Source. - Early in February 1943, investigations were begun for the location of the best sources of aggregate for concrete. Underground exploration revealed that the plant area was a valley covered by 50 to 300 feet of gravel, with pockets of sand existing in various locations. Further study and careful consider-

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ation of hauling costs, plant costs, and the critical nature of much of the aggregate plant equipment led to the conclusion that it would be better to develop only two principal aggregate sources and handle the transportation of aggregate from these sources to plant areas by rail. Accordingly, numerous exploration pits were opened, the character of the natural gravels was carefully analyzed, and the two pits that offered the best material capable of economical development were selected to supply the bulk of concrete aggregate required (See App. C 7).

(2) Mixing and Transporting. - Many studies were made as to the best method of mixing, transporting, and placing concrete. The bulk of the concrete was to be used in six buildings; the three Pile Buildings, and the three Separation Buildings. Detailed studies initiated in February 1943, and continuing until the middle of the summer of 1943, indicated the necessity of installing six concrete batch plants due to the wide dispersion of process areas and the impracticability of using one central batch plant. This made possible the use of pump distribution of concrete for the large placements in each area and reduced the amount of hauling by Transit-Mix trucks to a minimum. Work in each area was planned and coordinated to permit uninterrupted production of concrete. Consideration was given to barge deliveries of cement, but because the Columbia River did not offer dependable navigation up to Hanford or to the plant areas, it was planned to bring all cement in by rail. Wartime pressure on railroad equipment and the many expected source-shipping points for cement indicated an imperative need to provide unloading and handling

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equipment at each area for bulk shipment, either in hopper-bottomed cars or in box cars.

b. Critical Materials. - Close liaison was maintained with the War Production Board and with the various control agencies of the Army Service Forces to insure that minimum amounts of critical materials were being used and that substitutions for critical materials were being made in every possible way. However, the technical and scientific development studies and the experimental work that had been done indicated that there could be no substitution of materials in certain elements of the plant without endangering the success of the Project. The construction of an operating plant that would produce successfully with minimum possibility of failure was the ruling element in all decisions leading up to final design and construction plans.

2-4. Specialty Work. - Much study and thought were given in the early stages of planning as to how and by whom the various elements of the job would be done. As is normally the case in modern construction, specialty work such as plumbing, pipe fitting, electrical work, and steel erection was to be subcontracted to specialty contractors. By agreement between the Area Engineer and the Prime Contractor, items of work that could be isolated or handled independently would be done under subcontracts awarded to competent contractors to reduce the administrative load on the Prime Contractor and to utilize, to the maximum, construction talent in the region. The du Pont Company was to function as the general contractor, performing all work not adaptable to subcontracting.

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2-5. Transportation Facilities. - An existing railroad spur line reached into the site from the main line of the Chicago, Milwaukee, St. Paul and Pacific Railway at Beverly Junction, Washington, approximately 40 miles from Hanford, providing rail access to Hanford. State Highway 11-A ran through the Project from Hanford west toward Yakima. This highway formed the axis from which all Project roads were later developed. Other surfaced roads from Hanford to White Bluffs and from Hanford to Richland, and a graded but unsurfaced road from White Bluffs westward to the Midway Substation on the Grand Coulee-Bonneville power transmission line of the Bonneville Power Administration provided very convenient Project roads at the beginning of construction. These roads were fitted into the design of the plant road system to permit fullest utilization of these existing highways. Experience of the State Highway Commission Offices in these areas had indicated that roads that were not stabilized with oil or asphalt would break down seriously during the hot, dry, summer months; cause a serious hazard to vehicle operation because of dust and "washboarding"; and result in high costs of vehicle repair and maintenance. The compelling need of avoiding anything that might delay operations was an additional factor contributing to the decision to stabilize the road surfaces on all main routes by the use of asphalt and gravel, a road structure that had proved very successful in this area where ground water is not a serious threat to road stabilization. Railroad grades and railroad lines were planned to accommodate the operating plant, and sidings and extensions were planned wherever necessary to accommodate the special needs of construction.

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2-6. Process Areas Requirements.

a. Operating Plants. - At the beginning of the construction period only limited information as to the character of the plant structures was available. Only in a very general way were the physical requirements defined. When the physical and operating characteristics of the structures began to appear as engineering design, based on interpretation of scientific development work, it was apparent that the criteria set up for site selection were basically sound and that the best layout of the plant areas would approximate that tentatively planned during the site selection study (See Vol. 3). At this time it was believed that six production (Pile) plants would be required to meet the contract production requirements and that four Separation Plants would be required to process the material from the Piles. Accordingly, sites were selected within a central, 18 by 18 mile, area to accommodate six Pile Areas with two additional possible locations and four Separation Plants in two Separation Areas.

(1) Pile (100) Areas. - The Pile Areas were to be laid out close to the river because large quantities of water would be required to dissipate the heat generated during Pile operation. They were to be separated by a minimum distance of three miles, an adequate distance to prevent operational difficulties in one area from affecting another. Subsequently, it was determined that not more than four areas would be required. These were to be placed at alternate sites along the river to increase the distance between them and obtain better insurance against hazards. These alternate sites were approximately six miles apart. As design progressed it

became apparent that three Pile Areas would be sufficient to maintain adequate production (See App. A 2).

(2) Separation (200) Areas. - The Separation Areas were to be placed roughly eight miles south of the Pile Areas and beyond Cable Mountain, providing a physical separation of the two types of areas, which would protect each from any conceivable disaster originating in the other. Damage to one of the Pile Areas would not affect the operation of the Separation Areas except as it would limit the quantity of material to be processed. It was planned that each Separation Area should contain a pair of Separation Plants, to be served by a common service area including a power house, administration buildings, and electrical distribution facilities. The Separation Plants were to be placed roughly two miles apart, and the Separation Areas about four miles apart. Shortly after the beginning of construction it was determined that three Separation Plants with their related buildings would be adequate to serve the Piles (See App. A 2).

b. Water and Power. - As the principal use of water would be concentrated in the Pile Areas, it was decided that pumping of treated water from the Pile Areas to the Separation Areas would be the most economical means of supply. A completely dependable supply of treated water to each Pile was an essential requirement to successful operation as, according to the basic scientific theory, failure of water supply even for a few seconds might result in disaster (See Vol. 3). Therefore, a power source of the highest degree of dependability to maintain continuous pumping was a prime

consideration. It was decided that the best means of accomplishing this objective would be the installation of a dual power-supply system with motor-driven pumps connected in series with steam-driven pumps to provide for emergency operation in case of an electric power failure (See Vol. 3). The Midway Substation of the main 230-kilovolt transmission lines of the Bonneville Power Administration between Grand Coulee and Bonneville Dams was located at the west edge of the area. After careful studies of dependability and economics, it was decided to build a 230-kilovolt distribution loop originating and ending at Midway (See App. C 8). This loop was to be laid out to pass no closer than one and five-tenths miles from any production area, with stub lines reaching to the units, thus preventing trouble at one plant area from shutting down others. The main distribution circuits of the Bonneville Power Administration were carefully studied and switch gears installed at key points on their system to maintain a completely dependable power source.

c. Structures. - Mention has been made of the need for construction of massively shielded buildings as protection against radiations produced in the process (See Vol. 3). The Piles and all processing apparatus in which these radiations are present had to be provided with shielding, such as special masonite, iron, steel, concrete, water, or lead, depending on the specific requirements to be met. It was necessary that all component parts of the Pile and Separation Plant structures be erected with strict adherence to rigid tolerances. Construction under these virtually unparalleled conditions necessitated the use of special techniques and the highest

type of skilled craftsmen.

2-7. Richland Village. - Hanford Camp would be too close to the manufacturing plants for a permanent village, in view of the potential hazards involved in the production of plutonium. Richland was selected early in the planning of the Project as the site of the village for operating personnel. Because of the urgency of design work for the manufacturing plant, design of Richland Village was subcontracted to a local architect, including layout, design of buildings, and preparation of construction specifications subject to the approval of the Area Engineer. The construction of the village itself was also to be subcontracted and the subcontract work supervised by the Prime Contractor. Existing buildings in Richland were to be used for construction offices to the greatest possible extent. Because of the need for housing, all existing buildings were surveyed and even old houses that were definitely substandard were to be rented to construction employees, after making only the minimum of repairs required to make them fit for habitation. Some of the better buildings that could be economically rehabilitated were to become a part of the permanent village community.

2-8. Temporary Housing. - In addition to the planning necessary for construction of the permanent plant, a great deal of effort was expended in planning for the provision of housing both on and off the area for the enormous construction forces required on the Project (See Par. 5-2).

SECTION 3 - PROCUREMENT OF EQUIPMENT AND MATERIALS

3-1. General. - The procurement of materials and equipment, including all equipment used during the construction period, would have been a major problem under normal conditions. In this case, however, purchasing was required not only for the construction of a plant, fully equipped and ready for operation, but also for an adequate construction camp, ultimately to house and feed 45,000 construction workers; as well as a new permanent village to provide for approximately 15,000 persons, with attendant essential service, shopping, recreational, and religious facilities. The scarcity of materials and the complex nature of the job added to the difficulties. The lack of detailed design made it impossible at first to do more than give rough estimates of required materials, although wherever possible, these estimates were prepared on the basis of pertinent design details. In other cases they were the best estimates that could be made by the designers who had, at that time, only a general design layout to work from. The lack of knowledge as to detailed physical structures also complicated the planning of equipment necessary for construction. Tentative equipment lists were prepared, based on requirements of other war plant construction projects. Since the problem at Hanford was essentially one of building, concurrently, seven widely separated plant units, the scheduling of equipment utilization did not lend itself to direct comparison with other projects. Consequently, construction equipment and material requirements of the Project were continually revised as more and more in-

formation relative to the structural details of the various plant areas became available, and as construction progressed. Since mills and fabrication plants throughout the country were already operating at overload capacity on essential war production, it was necessary to provide for an uninterrupted flow of materials to this Project with the least possible disturbance to the over-all war effort, including other phases of the Manhattan District Project.

3-8. Geographical Factor in Procurement. - One of the controlling factors affecting the procurement program was the remote geographical location of the plant in relation to the principal industrial areas of the United States, where most of the construction equipment and materials were manufactured. In line with a policy of utilizing the services of local suppliers when practicable, for economy in transportation cost, it was necessary to make special surveys of West Coast plants and business organizations to develop sources of supply. Because of the requirements for special items, some in large quantities, so radically different from anything previously procured for commercial construction, it was necessary to canvass all industrial areas in the United States before suppliers with the required shops and production facilities could be located.

3-9. Procurement Operations. - Procurement of construction equipment and materials for the Hanford Engineer Works was accomplished by the Prime Contractor's Wilmington Office, the Prime Contractor's Field Office, the Hanford Area Engineer's Office, the Wilmington Area Engineer's Office, and the Washington Liaison Office. These offices and attendant agencies arranged the necessary prior-

itios and expediting to assure prompt delivery.

a. Contractor's Wilmington Office. - The Prime Contractor's Wilmington Office was responsible for the purchase of process equipment and specially designed items, all stainless steel stock requirements, and health and technical instruments. Procurement by this office was based upon material and equipment lists (See App. C 9), prepared by the Engineering Division at Wilmington, which gave the drawing detail number and equipment piece number of each item to be purchased for each building and for each area.

b. Contractor's Field Office. - The Prime Contractor's Field Office was responsible for the procurement of all materials and equipment for construction of temporary and permanent facilities and of such process items as were designated for field procurement. Procurement was carried on in accordance with required procedure as set up by regulations (See App. C 10), taking advantage, in necessary cases, of provisions for emergency purchase and for early delivery quotations. This office placed a total of 42,089 orders during the construction period (See App. B 5).

(1) Excess Materials Section. - All requisitions were first routed through the Excess Materials Section which was established for the purpose of screening all procurement requisitions in order to obtain as many items as possible from Government excess stocks. A block of numbers was established for transfer of heavy construction equipment, and delivery of material requested on such numbers became the responsibility of the Area Engineer's Equipment Section. All other transfers were arranged by the Area Engineer's

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Control Section. A total of 2400 HMT (Hanford Government Transfer) orders were handled by the Control Section as requisitioned by the Excess Materials Section. After the Excess Materials Section had screened a requisition and it appeared not feasible to obtain the material specified from excess or from Government sources, the requisition was assigned to a buyer for purchase.

(2) Field Expediting Group. - The Field Expediting Group was divided into two sections, the first group handling process equipment and the second handling construction equipment and materials. This group kept records on each purchase order relative to progress in fabrication or shipment, and was responsible for the delivery of equipment to meet the dates required for erection.

(3) Subcontracts Division. - During construction, the Prime Contractor let 81 subcontracts (See App. B & C 11) with a total value of approximately $54,000,000. All subcontracts executed with the Hanford Engineer Works were implementations of the Prime Contract and were drawn up and awarded by the Prime Contractor with the approval of the Area Engineer who was designated as the Contracting Officer by the District Engineer (See App. B 1). Throughout performance by the subcontractor, his work was under the general supervision of the Contracting Officer and any change in the scope of work, or in the amount of money involved, was made the subject of a subcontract modification which was preceded by a letter from the Prime Contractor to the Contracting Officer, recommending the proposed change and approval of the amount of money involved.

a. Hanford Area Engineer's Office. - Procurement of

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Hanford was carried on or expedited by two Government agencies in the Area Engineer's Office; the Control Section and the Procurement Section.

(1) Control Section. - The Control Section was established to act as a liaison and coordinating agency in connection with all procurement, and with the necessary priority and expediting assistance attendant thereto. It was responsible also for procurement of excess materials as requisitioned; for procurement from military and other Governmental agencies, including allocations of materials by Central Procurement Agencies; and for maintaining a record of the current status of all orders for essential process equipment. It also acted as liaison between the Prime Contractor and the Washington Liaison Office on matters other than procurement, such as: civilian requirements; establishment of quotas (for manufacturers and distributors) of ice cream, milk, and beverages; obtaining sources of supply when other procurement could not place orders; and other such matters requiring aid of the Army and other Governmental agencies.

(a) Central Procurement Agencies. - The procurement necessary through Central Procurement Agencies included all railroad rail and accessories; all lumber, with the exception of less than carload lots, obtained in emergencies with the written approval of the Area Engineer's Office; and all reinforcing steel.

(b) Excess Materials. - Excess material procurement was made from written requests submitted by the Contractor or requisitions from the various sections of the Area Engineer's Office. Approximately 1960 carloads of material were obtained through

procurement from excess supplies and the total value of the material handled on HOT (Hanford Government Transfer) orders was approximately fifty-five million dollars (See App. B 5 for some of these materials).

(c) Priorities and Allotment Quotas. - The Controlled Materials Plan set up by the War Production Board regulated the flow and supply of steel, copper, and aluminum to industry by quota allotments. This part of the priority system was handled by the Wilmington Area Engineer's Office and the Manhattan District Office at Oak Ridge, Tennessee (See Book I, Vol. 9), because practically all of the contracts involving these items were negotiated by the Contractor's Wilmington Office. Requirements for allotments to cover purchases containing these metals, involved in Hanford Area Engineer procurement, were handled by the Control Section through the District Office, although the quantities usually encountered were so small that they were covered by the "small order" provisions of WPB Controlled Materials Regulations. All priority matters relating to procurement for this Project were submitted to the Control Section for clarification and review. The Project priority rating, AA-3 from the start of construction to March 1943, AA-2X from April 1943 to July 1944, and AA-1 from July 1944 to completion of construction (See Book I, Vol. 9), was applied to all procurement in accordance with the priorities procedure as stipulated by the War Production Board for the Manhattan District. The Control Section issued the necessary priority certificates and approved all extensions of priorities by certification on the purchase orders. Approximately 4975 priority certificates were issued by the Area Engineer's Office. Higher

ratings were made available when necessary for procurement of limited quantities of critical items (See App. D 2). Approximately 1000 requests for higher than Project ratings were approved.

(2) Procurement Section. - The Area Engineer's Procurement Section handled all orders involving materials on Treasury Procurement Schedules (See App. G 12); all orders that of necessity had to be procured directly by the Government to avoid the restrictions imposed by War Production Board Regulations against Contractor procurement without prior WPB approval; and such items as were found by experience could be purchased by the Government with greater expedition. A total of 7200 orders (designated as HEW orders) were placed with this section.

d. Wilmington Area Engineer's Office. - The Wilmington Area Engineer's Office was set up to expedite process plant design and procurement. It was responsible for approving design of process equipment and granting authority for its procurement; procuring all process equipment appearing on Treasury Procurement Schedules and Quartermaster Contract Lists; approving all half-number purchase orders (those originating in the Contractor's Wilmington Office); and assisting in obtaining justifiable higher priority ratings, when requested.

e. Washington Liaison Office. - The Washington Liaison Office was organized by the Manhattan District to act as liaison for the various Manhattan District Areas in their transactions with any Federal Agency located in Washington. Its chief contribution to procurement was the expediting of priorities (See Book I,

Vol. 2).

3-4. Explanation of Purchase. - Purchasing was executed through the use of contracts, subcontracts, and purchase orders. In order to reduce the procurement of construction equipment, contracts were let, insofar as possible, to organizations possessing their own equipment. All Direct Contracts made by the Contracting Officer were "Lump Sum", with the exception of those awarded for expert services, and the Power Contracts which were billed on a monthly basis as per contractual agreement. "Cost-Plus-Fixed-Fee" subcontracts were awarded by the Prime Contractor for specialty work such as plumbing and electrical installations, and commissary and mess hall operation. Whenever possible, awards of contracts, subcontracts, and purchase orders were made on a competitive price basis. Other competitive criteria of award were early delivery, better quality, and required design, but some awards had to be based upon the only available source, and the

expediting of design and procurement. Whenever applicable it was standard practice to take advantage of lowest price, to insure equitable distribution of business among available vendors, and to expedite delivery.

4. Contracts and Subcontracts. - 57 Direct Contracts and 51 subcontracts were let during the construction period (See App. B 4). Whenever possible, the policy was to have the Prime Contractor arrange for subcontracting of all construction work that would lend itself to such an arrangement. In many instances, however, this formula was not applicable. It was mandatory that contracts for public utilities and Treasury Procurement Items, or with other Government

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agencies, be direct (See App. D 3). Often, for the purpose of convenience or speed, it was necessary for the Area Engineer's Office to contract directly with the vendor. The procedure with regard to Direct Contracts was that regularly used by the Corps of Engineers, except that the work was done under the direct supervision of the Prime Contractor's Office.

b. Purchase Orders. - Every purchase of materials and equipment for the construction of the Hanford Engineer Works was accomplished by the issuance of a purchase order. In cases where the supplying of labor at the plant site was involved, it was the practice to supplement this purchase order by a contract or subcontract. In the case of the Prime Contractor, purchase orders could be issued for any amount as long as they were used to further the objective of the Prime Contract and had prior Government approval. Direct Government purchasing procedure varied from this practice (See App. C 10). There was no limit to the value of material which could be secured by purchase order from Treasury Procurement Schedules or Quartermaster Contracts. One method of expediting the delivery of items for which there was no previous cost basis was the use of advance purchase orders, of which approximately 375 were executed. A total of approximately 7200 Government purchase orders with a total value of $14,300,000 was required throughout construction operations. The Prime Contractor issued approximately 47,000 purchase orders with a total value of approximately $150,000,000 (See App. B 3).

3-5. Procurement Expedients.

a. Critical Materials. - When the Project is considered

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from the standpoints of magnitude and secrecy, and the fact that this plant is unlike any other plant previously designed and constructed, it is quite obvious that many phases of procurement would differ greatly from those of normal projects. Such was the case, particularly, in regard to the acquisition of special equipment and the procurement of certain process items involving large quantities of critical materials and equipment. Critical and "long-time-delivery" equipment and materials were ordered as soon as design was sufficiently completed. Because of competing demands for such materials as structural and stainless steel, orders for these items were placed on the basis of preliminary design and estimated quantities, to provide for early placement of the requirements in the rolling schedules of the various mills. Although design was barely started, to avoid later delays orders were placed for relatively large quantities of special stainless steel (See Vol. 2) in selected sizes of plates, bars, and pipes. Arrangements were made with third parties for storing the material, when received from the mills, and later cutting it into proper sizes for shipment to the various fabricators. This scheme proved invaluable in avoiding a critical supply situation on stainless steel. Various specialty jobs such as welding reservoir tanks, asbestos covering on piping, steel erection in several places, the construction of a heat treatment unit, and similar items were awarded as subcontracts to specialty companies.

b. Split Orders. - Because of the immense requirements for special materials, equipment, and services, and because of the urgent construction schedule, it was often necessary to divide orders for

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similar items between several different suppliers, and, in some cases, to procure fabricating machinery for temporary installation in the vendors' shops to augment existing facilities.

3-6. Inspection. - The inspection phase of the procurement program was handled in accordance with normal Government practice. Inspectors were stationed at, or made periodic visits to, the vendors' shops to check the materials and equipment requiring inspection. In a number of instances, because of the radical departure from normal shop practice, difficulties were encountered in convincing the vendors that the close tolerances specified were necessary. However, through the use of new techniques and processes, and the cooperation of the Corps of Engineers and the Prime Contractor, the vendors were able to produce material of an acceptable quality for construction.

3-7. Construction Equipment. - A total of 11,189 pieces of major construction equipment was procured for use in the construction of the Hanford Engineer Works (See App. B G). Of this equipment, 9078 pieces were Government-owned. From the beginning of the war until the time construction was started on the Hanford Engineer Works, the Government had been the major user of construction equipment in the entire country. Therefore, although it was the policy of the Corps of Engineers whenever possible to hire contractors and subcontractors in possession of their own equipment, the Government found itself in the position of having to supply the greater part of the contractors' and subcontractors' needs.

a. Operation. - The Area Engineer at Hanford organized the Equipment Section to expedite the procurement of construction equipment.

A requirement list, which was constantly kept up to date, was submitted by the Prime Contractor to the Area Engineer for inspection. Upon approval by the Area Engineer, the lists were sent to the Equipment Section whose duty it was to procure the desired equipment from any available sources. Surplus lists of Engineer projects in the United States and Ordnance Supply Depot excess lists were carefully screened and desired items were noted. If the equipment was satisfactory, the importance of getting it ready for shipment was stressed and the necessary releases were promised, thereby saving valuable time.

b. Inspection. - Upon arrival of equipment by railroad, Government equipment inspectors made inspections as soon as the equipment was unloaded, and assigned a code number to each piece. A large field was set aside and all equipment was taken directly from the railroad, coded and inspected in this yard, and then sent to the Central Shops where it was serviced and assigned.

c. Coding. - The Corps of Engineers' official system of coding all equipment valued at over $300.00 was used. As there were 9076 pieces of construction equipment, plus 3676 pieces classed as small tools which consisted of electric motors, drills, air tools, lathes, and shop machinery used in maintenance shops, coding was a major job.

d. Rental of Equipment.

(1) Rental by Government. - It was decided early in the job to rent equipment, when possible, from individual owners or corporations, thus avoiding a monopoly of Government ownership in

construction equipment, and to waive the recapture clause in the contract if the Contracting Officer were unable to rent upon the recapture basis. Only in two or three cases could the recapture clause be made part of the contract, so that the rental costs in numerous cases were excessive.

(2) Rental to Subcontractors. - Although subcontractors were supposed to have all necessary tools and equipment when awarded their contract, it was often necessary for the Government to supply various types of equipment to expedite completion of a contract. The subcontractors applied for rental to the Prime Contractor, who in turn, asked the Area Engineer's approval to rent to them (See App. D 4). This system of rental to subcontractors was very beneficial to the Government and greatly expedited construction of the Hanford Engineer Works.

3-8. Property Control. - The large amounts of equipment and materials delivered to the Project necessitated strict control in shipping, receiving, and storing. Area Engineer and Prime Contractor agencies worked in close conjunction during the construction period to handle these operations to the best interests of their respective organizations.

a. Receiving and Storing. - The Prime Contractor received and stored all property on the site including government and subcontractor procurements, with the exception of merchandise purchased by the Olympic Commissary Company. The Receiving Department and Stores Department were so closely interrelated that they were considered as one. The Receiving Department acted as a clearing house for checking

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and coordinating incoming materials. The Stores Department stored, protected, and delivered supplies and other materials throughout the plant. Two departments, Stores and MS (Materials and Supplies) Stores, were established by the Prime Contractor to function as warehouses and disbursing points. The former was charged with the duties of disbursing items, such as tools, which were sold to personnel on the Project for cash. The MS Stores Department was established to account for items needed in practically all phases of construction, which could not be charged to any particular job at the time of purchase.

b. Major Subcontractors. - There were three major subcontractors connected with the Project, who used or consumed large quantities of materials and supplies. These were Henkee-James-Zahniser and Warren, plumbing subcontractors; Newbery-Chandler-Lord, electrical subcontractors; and Olympic Commissary Company, operator of mess halls and barracks. Each held cost-plus-fixed-fee contracts (See App. B 4).

(1) Henkee-James-Zahniser and Warren. - This subcontractor was given authority to issue his own purchase orders and be reimbursed by the Prime Contractor. Although he was making his own purchases, all materials were received by the Prime Contractor and delivered to the company.

(2) Newbery-Chandler-Lord. - This subcontractor was not permitted to issue his own purchase orders but was required to draw from the Prime Contractor's stock for materials needed in fulfilling his contract. Therefore, all materials used by this subcontractor were received and issued by the Prime Contractor.

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(3) Olympic Commissary Company. - The Olympic Commissary Company was given authority to make its own purchases and to receive all merchandise so purchased. The same procedure followed by the Prime Contractor was used by the subcontractor. The Prime Contractor spot checked this receiving and purchasing.

c. Area Engineer's Property Division. - The Area Engineer's Property Division was established to check and maintain records on shipments received by the Prime Contractor. The Division was divided into three sections; Accounts and Records, Field Audit, and Historical Records.

(1) Accounts and Records Section. - This section recorded the receiving reports from the Prime Contractor, including those of the subcontractors. Property accounts were maintained by the Property Officer in the Accounts and Records Section until October 1943. At this time, through directives of higher authority and meetings at various times between those concerned, the property accounts were turned over to the Prime Contractor, who maintained these records from this date forward throughout construction. After turning over the property accounts to the Prime Contractor, the Accounts and Records Section spot checked these accounts from time to time to insure their correctness and to assist in any way possible.

(2) Field Audit Section. - Duties of this section were to check receipt of property by the Prime Contractor and subcontractors; check contractor care of handling Government property; investigate and reconcile any irregularities existing between contractor records and the over-all record maintained in the Accounts and

Records Section; audit the Contractor's store accounts; prepare all field and warehouse reports on places where Government property was stored; and furnish the Accounts and Records Section with necessary information to maintain an accurate and up-to-date record of field conditions.

(3) Historical Section. - The Historical Section was charged with the responsibility of maintaining a photographic record of property. This section took pictures of all trust houses and maintained files to show what disposition of property was being made.

d. Excess Materials Department. - In order to utilize the stores of equipment and material available for transfer to this project from other Government operated agencies, the Prime Contractor was authorized to set up a department to control the transfer of this material to the Project. The Excess Materials Department was organized to handle incoming shipments but was later converted to handle outgoing shipments upon the completion of the construction program.

e. Surplus. - As construction neared completion, it was necessary to formulate a procedure for declaring excess and disposing of construction equipment and materials to other projects and Government agencies. A plan was established whereby all items declared excess by the Prime Contractor would be shipped to the Portland District Engineer's warehouses in Pasco, Washington, and the Portland District would act as disposal agent for the Project, releasing the Project of accountability. Surplus lists were prepared by the Property Division and submitted to the Manhattan District, which, for a period of thirty days, could issue shipping orders to cover items desired by

the District. After the thirty-day period, the remaining portion of each list was turned over to the Portland District for disposal. The Portland District was to furnish the Property Division with shipping orders to send the remaining items to other Government Agencies, as soon as possible. The Property Division, upon receiving shipping instructions from the Manhattan District or the Portland District would prepare shipping orders, furnishing information as to items to be shipped, method of shipments, and routing, to the Prime Contractor, who prepared the necessary items for shipment.

f. Salvage. - Items which were worn out or useless were salvaged and sold to private bidders. Collection and sale of all salvage was handled by the Prime Contractor. Invitation for bid letters were sent to three or more responsible bidders by the Prime Contractor, and upon receipt of return bids, the sale was placed with the highest bidder. The record of sale was prepared by an Area

Engineer representative in the Property Division and, when proper approval was obtained, the successful bidder was notified by a letter and requested to make arrangements for obtaining the salvage.

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SECTION 4 - CONSTRUCTION LABOR

4-1. General. - Even in the early stages of construction planning, it was obvious that the high percentage of war construction and production in the State of Washington and in the Northwest region (in relation to the existing civilian population) made the acquisition and retention of an adequate labor force to complete the Project a serious problem. This factor was recognized during the early stages of site selection, but it was considered that the problem would have to be accepted inasmuch as other conditions at Hanford were so favorable that this site still represented much the best known location in the country for the Project. Wage rates for the Project were established by an official predetermination made by the Department of Labor under the provisions of the Davis-Bacon Act on 18 February 1943 after thorough studies of the wage rate structure in the Northwest had been made (See App. C 13). The maintenance of an adequate working force of balanced craft workers was a constant problem that threatened delay in completion of construction all through the job.

4-2. Labor Procurement.

a. Recruitment Program Planning. - The first formal conference relative to the recruitment program for the Hanford Engineer Works was held at the Gray Building, Pasco, Washington, 31 March 1943, shortly after work had started on the site. The Deputy Area Engineer, management officials of the du Pont Company, and State War Manpower Commission officials were present. The WMC representatives stressed the necessity for absolute dependence of Hanford Engineer Works

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recruitment for construction on areas outside the Northwest region. Limited experience of the Prime Contractor with construction in isolated regions made it necessary to work out complete procedures, to train traveling recruiters, and to develop a trained recruiting organization to make the general large-scale recruiting operation possible and effective. It was also necessary to provide housing at Hanford for workmen, since it was obvious that the local area around Hanford did not have an appreciable excess of housing facilities. By the latter part of May 1943 various facilities were made available to a limited extent in Hanford by utilizing existing buildings, by erecting tents, and by building a few barracks. At that time another formal conference was held, attended by representatives of the Personnel Branch of the Army Service Forces, the Area Engineer, the Prime Contractor, and the War Manpower Commission. It was the recommendation of this group that the following steps be taken immediately to accelerate recruiting: (1) that the WMC should designate a local representative directly responsible to the Director of the War Manpower Commission and with full freedom to deal with all regional directors; (2) that recruitment should be extended into War Manpower Regions 8, 9, 10, 11, and 12 (See App. A 3); and (3) that arrangements should be made with the United States Employment Service whereby offices in those regions should offer employment at Hanford to workers contacting the office before offering them other essential employment either local or out of the region. The War Manpower Commission headquarters agreed to the recommendations, but they did not feel that they could issue instructions that local United States Employment Service offices

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give complete preference to Hanford over local employers engaged in essential war work. To effectuate the plan and recommendations, a recruiting team was established in Pasco, including a WMC representative, a representative of the Prime Contractor, and a representative of the Area Engineer. The WMC member, authorized to deal directly with all Regional Headquarters Offices in which recruiting was allowed, served to coordinate WMC offices on requests for personnel and clearances; the du Pont Company representative was given the responsibility of keeping the team posted on all requirements for labor; and the Area Engineer's representative had the function of collecting statistics relative to recruitment, maintaining contact with all Area and District Engineers of the Corps of Engineers who might have construction projects completed or nearing completion, and arranging with them to give Hanford a preferential opportunity to recruit workers being terminated.

b. Recruitment Operations.

(1) General Procedures. - The procedure all through the program followed a general pattern. Request was made to War Manpower Commission headquarters for clearance (See App. D 5) into other War Manpower Regions for specified numbers of men of various craft classifications. The WMC headquarters allocated the clearance request to regions according to their estimates of availability with least hindrance to local war industries, and notified the regional directors that they were to make every effort to meet that allocation. The regional directors and the state directors of the WMC offices then arranged, with the representative of the Prime Contractor stationed in

that region, for recruiting activities to be carried on in specific towns at scheduled times. Advertising was done by the WMC in cities and areas where recruiting was scheduled. At the same time the recruiting representative for the Prime Contractor in each region attempted to locate the best sources for recruiting, and, coordinating his efforts with the WMC offices, arranged to get clearance into the areas he considered best. Arrangements were made in the regions where recruiting activities were most intense and most productive, to assemble workers at a common point and arrange transportation to Pasco. Where the worker had no funds to pay transportation costs, a coach ticket was given him and the cost was deducted from his pay after his arrival at the job. Reports on the most critical needs, the open needs, and the needs filled were sent weekly to all the offices of the WMC concerned. This procedure for obtaining workers for Hanford was being used by July 1943, and was designed for the recruitment of common labor, leaving the procurement of skilled craftsmen to the Prime Contractor, who depended largely upon local labor organizations.

(2) Induction Program. - With the increasing impetus of recruitment, it became obvious that there was a breakdown of morale among the new recruits, and some loss of personnel was resulting from the arrival of these people in Pasco, Washington, in the middle of the night with no hotel accommodations and no one to receive them. In an attempt to get the new recruits on the job in an enthusiastic, or at least receptive, frame of mind, an official welcoming committee was set up to meet all Pasco trains; arrangements were made to provide barracks quarters for workmen arriving in the middle of the night;

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and a guide was on duty at all times to give new workers information as to where to go, what to do, and how to sign up for the job. This resulted in a considerable improvement in the attitude of new arrivals and increased the effectiveness of "channeling" the recruits to the job. The processing of new men required clearance with the United States Employment Service office in Pasco and the Prime Contractor's employment office in Pasco, transportation to Hanford--a distance of about forty miles, processing through the Hanford personnel office, physical examination, and preliminary security check. In addition, continuous efforts were made to streamline the procedure, permitting employees to start work and to collect pay in the shortest possible time.

(3) Recruitment Balance. - It soon became evident that the supply of common laborers arriving on the job greatly overbalanced the arrivals of skilled craftsmen. However, there was still an overall shortage of men. Since it was necessary to make every effort to keep forces balanced, the recruitment of common labor was slightly retarded and, in August 1943, recruitment through the War Manpower Commission channels was extended to skilled workmen. The request to the WMC for common labor was reopened in September 1943. Continuous efforts were made to keep recruitment balanced in order to satisfy current requirements for construction, and to correlate all activities through the WMC in order to assure that workers for Hanford were being recruited in the most productive areas and with the least amount of interference with other essential war programs. Numerous contacts were maintained with the regional offices of the WMC, to the extent that, at

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one time, the Project Manager and the Area Engineer made a personal visit to the regional offices in which recruiting was being carried on for the Hanford Project, to explain in some detail just what requirements existed and the compelling necessity for meeting these requirements. Copies of two secret letters, one written by Admiral King and one by Under-Secretary of War Patterson, outlining the absolute necessity of manning the Hanford Project adequately, were shown to the regional directors visited (See App. D 6). These visits were made in late September and early October 1943.

(4) Special Recruitment Procedures.

(a) Incentive Plan. - Because of the failure of recruiting activities in the fall of 1943 to produce a sufficient number of men to carry on the work, an Incentive Plan (See App. D 7) was approved by the War Department which provided for payment of railroad coach fare to and from the job to employees who performed satisfactorily a sufficient amount of work. Specifically, railroad coach fare was given to each man, up to a maximum of $100, from his point of recruitment to Pasco, providing the individual worked four months and his attendance was satisfactory. If he worked three additional months, the employee was given return railroad coach fare from Pasco to the point of his recruitment. Satisfactory attendance was defined as meaning that an employee should have less than two days of unexcused absence in any one month. Excuse for absence due to illness was granted when a certificate, authenticated by a physician, to the effect that the employee had received treatment and was unable to work, was submitted. While it is not possible to evaluate this plan specifically, it was

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apparent, when the plan was initiated in November 1943, on account of an immediate increase in arrival of workers, that the plan was basically beneficial. In addition, it was felt that this plan was instrumental in reducing turnover.

(b) Aid to Subcontractors. - The main concentration of effort for recruitment was for the Prime Contractor. However, various subcontractors were doing work on which completion was necessary to permit the Prime Contractor to maintain schedules, and they were also deficient in manpower. Steps were taken to arrange to have the du Pont recruiters also hire workers for these subcontractors.

1. Electrical Subcontractor. - In the fall of 1943, it became necessary for the electrical subcontractor, Newbery-Chandler-Lord, to seek assistance in his recruitment of electricians and linemen. The electrical subcontractor sent recruiting representatives to local unions in an attempt to have more workers referred to the Project. It became evident that this would not take care of the situation, and, in July 1944, an agreement (the Brown-Patterson Plan) was reached between Robert P. Patterson, then Under-Secretary of War, and Edward J. Brown, the President of the International Brotherhood of Electrical Workers. This plan provided that employed electricians engaged in activities less essential than Hanford could be released for ninety days to work on this Project and then return to their former employment with full protection of seniority rights. Through this plan 233 electricians and 89 linemen were secured. Men were allowed round-trip fare, and subsistence of $2.50 per day during travel status, upon completion of the 90-day period, rather than the transportation

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allowance offered under the standard Incentive Plan. Enough electricians and linemen were transferred to the Project to meet the work schedule and maintain balance with the other craft work.

2. Plumbing and Pipe Fitting Subcontractor. - The piping subcontractor, Hankee-James-Zahniser and Warren, was unable to maintain a sufficient force of pipe fitters; therefore, starting in August 1944, his recruitment efforts were aided by the Prime Contractor. Arrangements were made with the Union to permit all classifications of members of the International Association of Plumbers and Pipe Fitters to work on the Project as construction workers. This departure from standard procedure on the part of the International Association made available a number of additional men for the construction work. These efforts still provided less than the number needed and arrangements were made whereby any local union recruiting 20 or more pipe fitters could call for and receive Air Transport Command transportation for the men from their home station to the job site. Four plane loads of plumbers were recruited and transported from the Southwest to the job in this manner. The needs were still not being met, and in August 1944 the Secretary of War directed the Chief of Staff to release 200 skilled plumbers and pipe fitters from the Army, stipulating that they should be in limited service status and not qualified for overseas duty. These men were put in the Enlisted Reserve Corps and were hired by the piping subcontractor at the standard rates of pay for civilian workers. Arrangements were made for the union to clear these men without regard for previous affiliation or present membership in the union. The first of these men arrived 1 September

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1944 and in all, 198 Enlisted Reservists reported for duty on the job. They were originally authorized for 90 days' work before returning to their duty station, but as they were still greatly needed, a 90-day extension was authorized. A striking result of the drastic and unprecedented step by the Army of releasing enlisted men to work on the Project was its beneficial effect on the rest of the men in all crafts, in impressing them with the obvious importance of the work.

(c) Recruitment in Alaska and Canada. - During October 1943, many efforts were made to exercise priorities established in order to meet manpower needs for the Project. Through the Office of the Commanding General of the Manhattan District Project, arrangements were made to interview American workers leaving United States war projects in Alaska and Canada. The program provided for interviewers, traveling on trains between Red Deer and Calgary, and Melville and Winnipeg, to contact workers and distribute among them literature concerning the Hanford Engineer Works. The program was pursued until the end of December 1943, when lack of tangible results made it advisable to discontinue this phase of recruitment.

(d) Union Recruitment. - In October 1943, through the Corps of Engineers' contact with the Building Trades Council of the American Federation of Labor, an arrangement was made whereby the business agents of several unions actively recruited craft personnel for the Hanford Engineer Works, referring them to the local United States Employment Service offices at the points of recruitment. Following this initial referral, they were channeled to the central United States Employment Service Office, where clearance was made to

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the du Pont representative for employment on the Project. Upon recommendation of the Corps of Engineers, Kansas City, Missouri, was established as the central point for the plan. A group of selected Labor Relations Officers and other personnel were sent to Kansas City to determine whether or not an adequate flow of craft personnel was entering this central point from the initial referral points, and, if no flow was evident, to check immediately by personal visits to union offices and local United States Employment Service offices. It was also the responsibility of this group to recommend such revisions to procedures and activities as would stimulate flow of craft personnel to the central clearing point. Despite the support of this recruitment plan by union representatives and the personal time devoted to it by a National Representative of the Hod Carrier and Labor Unions, nothing of a tangible nature was accomplished. As a result, the program was discontinued early in November 1943.

(e) Direct Hiring Program. - The need for carpenters and laborers had remained critical from the early part of September 1943. It had become increasingly apparent that the regular recruitment efforts were failing to lessen the severity of the situation. To supplement the regular recruitment, therefore, the Direct Hiring Program was developed, under which the United States Employment Service offices were allowed to hire employees for the Hanford Engineer Works directly rather than to refer the applicant to a Hanford recruiter for interview and hire. This program was inaugurated in November 1943, and was pursued for approximately one month, in which time 1414 persons (457 carpenters and 957 laborers) were hired by the

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United States Employment Service offices. Of the 1414 persons hired, 1123 arrived in Pasco and were subsequently placed on the payroll.

(5) Spanish-American Recruitment. - The War Manpower Commission officials of Region 10 (See App. A 5) felt that any recruitment program undertaken in that region would be unproductive unless it were possible to hire non-English-speaking Spanish-Americans. The housing of these people represented a potential racial problem in the construction camp at Hanford; however, arrangements were made to accommodate, in a separate camp, the number that might have been expected and efforts were started February 1944 to recruit Spanish-Americans from Region 10. Special investigators were dispatched to the region to make local spot security checks on applicants. Despite the high concentration of recruiting efforts and the special arrangements made to clear the recruits, only 54 Spanish-Americans were hired during the period from February 1944 through April 1944, when the program was abandoned.

(6) Recruitment Results. - The peak of the recruitment program was reached in July 1944 when recruiting was being carried on in all twelve War Manpower Commission regions with 153 recruiters on the road. Throughout the program, close cooperation and collaboration was maintained with the WMC offices and the United States Employment Service. Numerous conferences were held, both in the field and in Washington, D. C., to coordinate the recruiting program, to outline plans and procedures, and to assure that all local field men, both for the du Pont Company and for the USES and WMC, were taking advantage of every opportunity to send qualified personnel to Hanford.

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For example, at one time when it was felt that reports reaching [redacted] officials from disgruntled employees were developing erroneous impressions of working and housing conditions on the job, key [redacted] officials were invited to visit the Hanford Camp and see the conditions for themselves, notwithstanding the irregularity of the proposal from the viewpoint of security. Several visits were made and the reports of these official visitors to [redacted] headquarters were uniformly favorable and assisted materially in dispelling the rumors about Hanford Camp that had, to some extent, inhibited the effective recruitment of workers. Misunderstandings that developed in the necessarily close cooperative activities of the Manhattan District with the Contractor, the Corps of Engineers, and the [redacted], were comparatively few and were settled to the mutual satisfaction of all parties concerned, in most cases by personal conferences. In all, recruitment was carried on in 745 cities in 47 states, the District of Columbia, Canada, and Alaska; 262,040 people were interviewed by recruiting representatives and, of these, 94,307 were hired (See App. B 7). The cost of recruiting workers for the Project, which includes all costs of getting a worker to the site and on the payroll, averaged $52.38 per recruit (See App. B 8).

4-5. Labor Relations and Utilisation. - One of the most difficult problems solved at the Hanford Engineer Works was the supply of common and skilled labor. "Critical Crafts Charts," showing in detail the requested force in various crafts and the actual force supplied for the construction of the various plant areas, have been compiled (See App. B 9). It is apparent from an inspection of these charts that

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the supply did not meet the demand during the first two-thirds of the construction period. This situation was met with a variety of expedients. A nation-wide recruiting program, directed toward placing men on the job, was necessary to increase the on-roll figures in all brackets.

a. Labor Utilization.

(1) Work Week. - The use made of the workers after arrival entailed other expedients. Lacking sufficient men to perform necessary tasks in a 48-hour week, it was a natural step to extend the work week in order to obtain more work from the available manpower. The standard work week for the Project was extended from 48 to 54 hours on 20 September 1943 and remained at the latter figure for the duration of construction. For varying periods, when over-all progress required immediate completion of items of special craft work, steam fitters worked six ten-hour days; carpenters, laborers and truck drivers worked five 9½-hour days and one eight-hour day, a total of 56½ hours per week. Shift work and Sunday work was approved in specific instances to expedite critical portions of work.

(2) Training. - Because of the extreme difficulty in obtaining construction workers for the Project and the exactness with which much of the work had to be performed, training programs for all types of employees were inaugurated and carried out during the course of construction. Depending upon the type of work required and the type of trainee, these varied from straight-day training courses before the employee actually began work to night refresher courses offered on an optional basis. In addition to craft training, there

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were also training periods for supervisory personnel, and booklets were published from time to time outlining methods leading to better workmanship and greater efficiency (See App. D 8).

(3) Distribution. - A series of craft charts containing long range estimates of requirements and the actual manpower secured were compiled for the following groups (See App. B 10):

Labor	Reinforcing Steel
Carpenter	Piping
Carpenter Labor	Earthworks
Concrete	Paints
Mechanical	Electrical
Transportation	Rigger

It will be noted that in many instances the peak force indicated in the estimate was later exceeded by the figures for men actually working. This was necessary principally because the manpower was secured after the period for which its use was originally scheduled, making the higher figure at a later date a requirement in order to meet completion schedules. The total peak force was reached on 21 June 1944 with 45,096 employees on the roll in all crafts. Below is a tabulation of the weeks in which peaks were reached in the various groups:

Craft	Peak	Date
Labor	6500	25 June 1944
Carpenter	5250	2 April 1944
Carpenter Labor	690	19 December 1943
Concrete	1540	25 June 1944
Mechanical	2660	9 July 1944

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Transportation	4188	5 August 1944
Reinforcing Steel	530	4 June 1944
Pipe	1900	1 October 1944
Earthworks	980	13 February 1944
Paint	535	5 September 1944
Electrical	1930	15 August 1944
Rigger	1580	10 September 1944

It should be understood that the above figures are for individual crafts only at the periods stated, while the total peak force figure given above for 21 June 1944 encompasses all personnel on the Project--employees of the Prime Contractor, subcontractors, and the Government at that time. In addition to the craft charts, a composite chart of the Project also was prepared (See App. B 11). From it may be obtained the forces of the Prime Contractor, subcontractors, and daily working forces, together with Project expenditures, safety hours, and major and minor injuries.

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b. Organized Labor Union Activities.

(1) Union Relations. - At the beginning of the construction work, a number of conferences were held between the Building Trades Department of the American Federation of Labor and the Contractor. No written agreements were made, but it was verbally understood that all construction workers would be cleared through the proper craft union of the Building Trades Council, with headquarters at Pasco, Washington. Consistent contact was maintained with craft business agents and representatives of the Building Trades Council. To expedite construction operations, a number of very unusual concessions were

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made, such as setting aside normal jurisdictional procedure and, where shortages were serious, permitting members of certain crafts to work out of classification to insure completion of critical work where craft shortages existed. For example, in many instances boilermakers and machinists were allowed to do plumbing and pipe fitting work and carpenters were allowed to work as millwrights. The basic reason for making these concessions was that shortages existed in one craft while other crafts had surpluses. This cooperation between various union craft representatives greatly improved the balance of crafts and made it possible to maintain working schedules and coordination of work to fit completion objectives. In fact, it is doubtful whether work would have been completed on schedule, had these cooperative agreements not been reached.

(2) Labor Difficulties. - Some difficulties developed both with the United Association of Plumbers and Steam Fitters and the International Brotherhood of Electrical Workers, which were finally settled by the unions. In the case of the electricians, jurisdiction was transferred from the local union to an International Representative stationed in Pasco. The United Association of Plumbers and Steam Fitters had operated essentially on that same basis from the beginning of the job. As on all other construction projects of the Corps of Engineers, the business agents of the various local unions were not permitted to operate on the working site. In the case of jurisdictional disputes, an exception to this was made in two or three instances. At that time, the International Representatives of the disputing unions were taken to the site of the dispute, so that they

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could view the work and arrive at a better understanding of the situation. It is considered that labor difficulties, insofar as the unions were concerned, were at a minimum on this Project. This can be verified by comparing the total number of man-hours required to complete construction with the total number of man-hours lost through work stoppages. It is believed that this fraction will compare favorably, if not exceptionally, with any war industry in the country. A chart of all work stoppages during construction was compiled (See App. B 12). In connection with work stoppages it is significant that:

1. The total man-hours lost through work stoppages (15,060) was .011 per cent of the total man-hours spent on the job (126,265,652).
2. Only two of the stoppages resulted from controversies with management. During the two stoppages, a total of 205 man-hours was lost as compared to a total of 14,855 man-hours lost in the two jurisdictional disputes.
3. None of the stoppages delayed completion of the job.
4. All the stoppages were settled as rapidly as possible—the shortest one (13 March) lasted one hour—the longest stoppage (7 September) lasted twenty-eight hours.

c. Selective Service.

(1) General. - A considerable problem in procuring and

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maintaining an adequate working force was the possible withdrawal of men by selective service. The necessity of safeguarding the security of the Project limited the amount of information that could be given to the local selective service boards in regard to the essential duties performed by the registrants. Since many of the cases were handled by four local boards near Hanford and all appeal cases were handled by the Washington State Appeal Board in Spokane, these boards were invited to inspect the Project late in 1943. These visits gave the board members a better idea of the importance of the work and this, coupled with the sympathetic and vigorous efforts of the Washington State Director and National Selective Service Headquarters, made it possible to retain essential personnel on the Project.

(2) Methods. - All recruiting personnel were instructed to concentrate on those men least likely to be lost because of the requirements of selective service, i.e., men 38 years of age or over, pre-Pearl Harbor fathers, those classified 4-F, and those holding occupational deferments. The degree to which this was accomplished may be seen to some extent in the following data taken from a report of 4 March 1944 (See App. C 14). Of the men employed by the Prime Contractor 51 per cent were 38 years of age or older, and of 3175 men between the ages of 18 and 26, 75 per cent were 4-F. The Prime Contractor and the subcontractors had Selective Service Sections through which all selective service business was handled. All applications for deferment were referred to the Selective Service Section in the Area Engineer's office for approval. If the application was approved it was forwarded to the local board accompanied by a letter signed by the Area Engineer

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certifying that the work was of vital importance to the war effort and that the registrant was employed on construction work (See App. D 9). In the case of certain key personnel the "West Coast" plan (See App. C 15) was invoked if necessary and completed D. S. S. Form 401-A (See App. D 10) accompanied the request. Copies of the above letter and the Prime Contractor's Selective Service Flow Chart are included in the appendix. In the case of registrants over 38 years of age, only D. S. S. Form 42-B (See App. D 11) was used.

(3) Results. - From 1 April 1943 to 1 November 1944, the Prime Contractor's Selective Service Section handled 14,701 cases, of which approximately 80 per cent received favorable action. While the number seeking deferments seems high, it represents only about ten per cent of the men employed in construction during this period. The work of this section was accomplished at an average cost of $4.06 per case (See App. D 12). In addition to this work a transfer board was established by this section on 6 March 1944 in cooperation with the Washington State Selective Service System, which handled the transfer of pre-induction physical examinations to local boards near Hanford. A total of 1760 pre-induction physicals were transferred, resulting in a saving of approximately 22,000 man-hours.

4-4. Employee Relations.

a. Turnover. - The acute labor turnover rate experienced in the early stages of construction, brought about by lack of complete facilities at the Project, threatened to delay completion of construction. Activities of the Utilization Committee and a "Stay-on-the-Job" Campaign were instrumental in reducing the rate of turnover to a point

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where it no longer seriously impeded construction.

(1) Utilization Committee. - At a conference held in Washington, D. C., by representatives of the War Manpower Commission, Army Service Forces Headquarters, and the Corps of Engineers, it was agreed that a team representing each of these agencies be formed to investigate and report on conditions of employment at Hanford, and to submit recommendations for reducing turnover and termination rate. This meeting was held on 3 May 1944 and within a few days, the team was on the Project and active. Careful field studies were made and control charts reviewed. Control charts of employment, terminations, reasons for terminations, projected requirements for labor of various classes, and other details had been maintained in an effort to isolate factors that were causing loss of workers and to permit formulation of effective measures to reduce these factors. This team worked out a number of recommendations which were discussed with the Prime Contractor and corrective action was taken when practicable. Following the first investigation by the team, it returned to Washington, D. C., and, on 18 July 1944, submitted an analysis of what had been done and what remained to be done to improve working conditions and to reduce terminations and other factors adversely affecting the job. Activities of the team resulted in many improvements in processing personnel, in better balance of camp facilities, and in increased social activities, which served to keep the workers contented and induced higher output per worker. The specific improvement could not be evaluated accurately but could be sensed from the changed attitude of the people on the job and the reflected improvement as indicated on the control charts. A

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significant fact brought out by the control charts was that the greatest percentage of terminations occurred almost concurrently with peaks in recruitment (See App. C 16). A separate study indicated that approximately half of those terminating were workers who had been on the job four weeks or less.

(2) "Stay-on-the-Job" Campaign. - In August 1944 a "Stay-on-the-Job" Campaign was inaugurated and an Employees' Victory Council was chosen to sponsor the program. From the obvious popularity of the activities sponsored (approximately 50,000 persons viewed exhibits of United States Army and Navy equipment and captured German and Japanese material, and the average attendance at showings of motion pictures dealing with war subjects was over 2000), it was believed that the campaign was of definite value and that it encouraged many of the more stable and dependable employees to "Stay-on-the-Job" longer than they had planned.

b. Absenteeism. - The nature, location, and working and living conditions of the Hanford Project combined to make absenteeism one of the major problems. This problem became evident within a few months of the start of construction. A program aimed at reducing absenteeism was developed and was carried out during the entire period of construction. The program was initiated by means of posters in buses and in other prominent locations throughout the Project. A "Presentee" Contest between the various crafts was started on 1 November 1943 and ran for a period of eight weeks. It was given Project-wide publicity and developed a high competitive spirit. By the end of this campaign, absenteeism on the Project had decreased from 9.8 per cent at the start

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to 5.9 per cent. Thereafter, percentages were kept for each craft on a signboard erected in Hanford and the standings were changed weekly. The over-all minimum was reached in the week ending 30 September 1944, when absenteeism hit an all time low of 5.3 per cent. Individual crafts bettered this figure in many cases. The average for all crafts came down fairly steadily all through 1944, so that by autumn of that year the weekly average of absenteeism ranged from 5.3 per cent to 6.7 per cent (See App. C 17). This range compared very favorably with war plants in all parts of the country.

c. Living Conditions. - The adverse effects of arid summers, extremes of temperature from 110 to -18 degrees Fahrenheit, prevalence of strong winds and frequent dust storms, isolation from large cities, and lack of family quarters near the Project conspired to reduce employment at Hanford and to increase the difficulties of maintaining an adequate working force. A violent dust storm, either in the plant areas or at Hanford, uniformly resulted in a disproportionately large number of terminations during the two days following; in fact, dust became known as "termination powder." Housing of workmen at Hanford was a major problem in itself. The first few workmen were temporarily housed in existing buildings and tents. The compelling need for constructing the plant in the shortest possible time necessitated the concentration of all early effort on preliminary work in the plant areas to the exclusion of all but very limited facilities for the camp residents. This policy of postponing facilities did not result in serious dissatisfaction for the first few weeks, when the camp was small. Upon the recommendation of the Contractor and the approval of the Area

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Engineer, the Washington Liaison Office, through cooperation with the War Production Board, the Office of Price Administration, the Rubber Director's Office, the Petroleum Administration for War, the War Food Administration, and other agencies in the Government, succeeded in obtaining increased rationing allotments for the benefit of the Project workers throughout Yakima, Benton, and Franklin Counties. "Isolation gasoline" (additional quota to compensate for the extreme distances between Hanford and the neighboring towns) was made available to the workers on the Project for travel to the extent of 225 miles per month. Food quotas, including soft drinks, ice cream, and beer, were increased in proportion to the increase of population throughout the above-mentioned counties. These increases applied also to clothing and other civilian necessities, and to newsprint allocated to the leading newspapers serving the district in which the Project was located. Upon being apprised of the urgent requirements for auto tires for civilian use, the Washington Liaison Office, working with the War Production Board, arranged for higher quotas and allotments as requested by the Office of the Area Engineer. This applied also to an increased supply of cigarettes which was made available for the personnel employed on the Project. The items listed above are only a few of the more salient features for which assistance was received. As the camp grew and as the employees' stay lengthened, it became necessary to provide more social and recreational facilities to maintain morale and worker efficiency. The isolation of the Hanford Engineer Works and the limitations placed on transportation by wartime needs restricted visits of the worker population to neighboring cities, and necessitated relatively complete

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facilities and a varied recreational program to keep the people occupied in their leisure time.

(1) Commercial Facilities. - Commercial facilities were provided to serve the workers and the families in the trailer camp. Drug stores, grocery stores, a Post Office, and a bank were provided and the operators were encouraged to provide every possible means of service to the population to induce them to transact their business at Hanford rather than to take time off to leave the area.

(2) Racial Segregation. - In the early stages of the construction camp there was no segregation of races; however, after a few months the colored population requested separate housing and recreational facilities and their request was granted.

d. Recreation. - Since it was difficult to provide recreational facilities in the camp without hindering productive work in the plant areas, the facilities considered desirable were made available on a priority basis, working first toward the minimum facilities that would provide activity for the greatest number of people. A men's recreation hall, and such items as pool tables, ping pong tables, a beer parlor, a lunch room, a news stand, a barber shop, and telephone stations were first provided. Women's facilities of a comparable nature were provided as the camp grew. Improvised structures were employed wherever possible, to permit early use and to prevent diverting men from plant construction to camp construction. For example, a tent theatre was opened in October 1943 and shows were held there until the theatre building opened in December 1943. Open-air movies were shown in Hanford during the summer of 1943. A beach on the Columbia River

was provided with a raft and swimming facilities. Taverns were opened, and stage shows, dances, boxing matches, basketball tournaments, and other community entertainment programs were held in mess halls and in the open air until an auditorium was placed in service in June 1944.

(1) Worker Activity.

(a) Hanford Engineer Works Employees' Association. - The Hanford Engineer Works Employees' Association was formed by the employees at Hanford, with its announced purpose the sponsorship of recreational, educational, and entertainment activities for the workers on the Hanford Engineer Works Project. This Association figured largely in the social affairs of the Hanford Camp and was instrumental in providing the opportunity for much fuller life to the workers while in the camp. One of the principal activities of the Association was the publication of a Project newspaper, which was a necessary medium for conveying to the workers information such as explanations of policies and basis reasoning for any changes in procedure. The paper also presented schedules of events, social activities, bus transportation, movies, and other items of camp interest.

(b) "Day's Pay" Bomber. - In June 1944, a group of workmen conceived the idea of launching a drive to collect money to buy a bomber for the Air Forces. This was done under the sponsorship of a committee of workmen. On 4 July 1944, in order to accelerate the contributions to the bomber fund, an air show was staged at Hanford with the aid of the Army and Navy air services in the vicinity. On 23 July 1944, the bomber was flown to the Project landing strip at Hanford from the Boeing Plant in Seattle, and presented with appropriate ceremony

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to the Fourth Air Force, represented by the Commanding Officer of the Walla Walla Air Base and The Commanding General of the Fourth Air Force. The ceremony was attended by an enthusiastic crowd of workers and their families. The bomber was christened "Day's Pay," as the drive was based on the contribution of one day's pay from each worker.

(2) Child Welfare. - Considerable emphasis was placed on children's activities to prevent the spread of juvenile delinquency that might result from the insufficiency of home life in the construction camp. Practically all of the families in Hanford lived in trailers and all social life was necessarily limited to activities outside the home. Boy Scout and Girl Scout troops were organized and given considerable support in maintaining their activities. The Federal Works Agency, in cooperation with the Hanford School District, provided nursery and day school facilities, through the use of funds provided under the Lanham Act (See App. C 18).

(3) Results. - In all, the recreational program, which was based entirely on unselfish and unstinting effort on the part of a great number of employees who lived in Hanford, proved very successful and may be credited with an important part in the enormous job of construction of the Hanford Engineer Works.

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SECTION 5 - TEMPORARY CONSTRUCTION

5-1. General. - The provision of housing for construction workers, with attendant services and facilities, and of necessary shops and facilities for construction work was essential to the erection of the permanent plant and necessarily of first consideration. This temporary construction included: the building of Hanford Camp, an auxiliary construction camp, and the construction plant and services; installation of facilities at off-area housing sites; and rehabilitation of existing residences on the reservation outside of the Richland Village area.

5-2. Hanford Camp (See App. A 4, 34). - Before the scope of the work had been completely defined, it was believed that a peak force of 25,000 to 28,000 workmen would be sufficient to complete the job, and that approximately half of this force could be absorbed into communities adjacent to the Project. In the construction planning, it was decided to centralize all housing of construction workers in the Hanford area rather than to establish separate camp facilities in each area. Early in the construction period, an investigation conducted by the Area Engineer in conjunction with the Prime Contractor indicated that the housing facilities in surrounding communities could accommodate only a few thousand of the employees required. In addition, as work progressed, it became evident that the initial manpower estimates were low. These two factors necessitated major increases in the size of the construction camp. Adequate, though temporary, facilities had to be provided to meet the essential minimum requirements of a peak

population of 51,000 with respect to food, quarters, clothing, health, schools, churches, recreation, transportation, and police and fire protection. Eventually, about 35,000 persons were accommodated in barracks type quarters and about 12,700 in trailer camps (See App. B 13).

a. Preliminary Studies. - Prior to the establishment of temporary construction offices for the Hanford Engineer Works, a thorough investigation was made of other large projects in areas having climatic conditions similar to those found on the plant site (See App. C 19). Particular note was made of the arrangement of feeding and housing facilities, sanitation and health, worker relationship and morale, and police work. After many different types of barracks had been studied, it was decided that the most economical type of housing of desirable quality would be a light frame building with double rooms throughout. Investigation of various schemes for heating the buildings indicated a forced air circulation system working through steam coils as the most economical. Studies were made as to the value of a central heating system as compared to individual heating units for each building or for each group of buildings, and the central heating system was adopted for the entire Hanford Camp except in isolated buildings where portable electric or coal space-heaters were installed. Knowledge gained through these preliminary studies facilitated the organization and planning of Hanford Camp.

b. Site Requirements. - The factors governing selection of a site for housing the construction workers were:

1. A location that provided easy access to the work

areas and would permit construction of the process areas in such a manner that the farthest areas could be completed and placed in operation without causing abandonment of the camp because of safety considerations.

2. Easy access by both road and rail.

3. Provision of water and power utilities which would lend themselves readily to expansion.

4. Existence of buildings readily available for use as temporary offices and living quarters for the workers needed to start construction.

c. Selection of Site. - Three separate plans (See App. D 13) were studied prior to the selection of the Hanford Camp site. After investigation, the Hanford site was considered the most logical selection because it so adequately satisfied the requirements for the site. Hanford, located on the west bank of the Columbia River, was a small community with a population of approximately 128 at the beginning of the construction period. The natural contour of the land made sewage disposal and drainage a simple problem and required no earthwork grading for building construction. Hanford was situated at the intersection of a secondary state highway, leading from Connell to Yakima, and the Pasco-White Bluffs road. The community of Hanford contained a number of residences, commercial stores, two fruit packing warehouses, a stock yard, passenger and freight station, Grange Hall, Masonic Hall, a combined grade and high school, and a church. The town area was served by a local water system and by an electrical

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distribution system which was connected to the Pacific Power and Light Company substation installed at that location. It was also served by a branch line of the Chicago, Milwaukee, St. Paul and Pacific Railroad, which terminated at Hanford. Most of the area in the immediate vicinity of the town was irrigated farmland at the time construction forces arrived on the Project.

d. Construction Operations. - At a planning meeting held 1 April 1943, a schedule was made of the force requirements necessary to accomplish the preliminary construction planned for the period from 10 April 1943 to 1 June 1943 (See App. C 20). To accommodate this force, it was considered necessary to start construction of barracks units immediately, with mess halls and service buildings to follow as required. An adequate force could not be employed on this work until portions of the camp sufficient to house it could be completed. On 3 April 1943, the Prime Contractor's Layout Department began preliminary surveys for the construction of the Hanford Camp, the Administration Area, and other temporary construction in this vicinity. On 6 April 1943, a general reconnaissance of the Hanford Area was made by representatives of the Area Engineer and the Prime Contractor. Special attention was given to the camp building locations and the location of the utilities and facilities which would be required for the operation of the camp, administration, and service buildings. Upon completion of this field reconnaissance trip, it was decided to begin construction work immediately on a camp capable of housing and feeding 3000 workers and to order materials and equipment for additional units to increase the capacity of the camp to 4000.

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The original camp was composed of ten four-wing men's barracks, ten two-wing-type women's barracks, a central mess hall, and a commissary building.

(1) Camp Planning and Studies. - Starting 15 May 1943, bi-weekly meetings pertaining wholly to Hanford Camp construction and planning were held by the members of the Prime Contractor's staff responsible for the construction and operation of the camp, to determine the sequence of building construction based upon the need to meet the anticipated demands for housing, feeding, and commercial facilities; and to discuss, for immediate action, the procurement of critical building materials and equipment and the elimination of any factors which might delay construction. Starting 19 June 1943, the meetings were held weekly. On 27 July 1943, Jones, Couillam, Thary, and Sylliaasen, Architect-Engineers, were commissioned to study existing housing and traffic conditions and to assemble pertinent information from the Prime Contractor's drawings and maps. A "Housing and Traffic Analysis of the Hanford Camp Area" was submitted by the architect-engineers on 17 August 1943 after field investigations and preliminary studies had been made (See App. C #1). In resolving the problems encountered, careful attention was given to the temporary nature of the entire enterprise and the necessity for the utmost speed in construction. The further extension of the barracks and hutment area, the trailer camp, and the service area, the construction of the shopping center, and the control of traffic, closely followed the recommendations outlined in this report. Various studies were made from time to time by the Prime Contractor's Field Industrial

Engineering Department with respect to operation and further expansion of the camp. The results of these studies were reviewed and many of the recommendations made were incorporated in the operation of the camp.

(2) Housing. - Three principal types of housing and sleeping quarters were provided at Hanford; namely, barracks for white men, white women, colored men, and colored women; hutments for white men and colored men; and trailer parking lots for all Project employees with trailers. The Prime Contract embodied all provisions of the Fair Employment Practice Order (Executive Order No. 9346), which prohibited any discrimination because of race, color, or creed. While Executive Order No. 9001 (issued under authority of the First War Powers Act of 1941 and in effect when the Prime Contract was negotiated in February 1943) was not as inclusive as E. O. No. 9346, dated 27 May 1943, the Prime Contract anticipated and incorporated all provisions of the latter order with reference to subcontracts and anti-discrimination therewith and, therefore, no supplement was necessary. Although the colored people of their own volition requested separate barracks, mess, and recreational facilities, they were in no way prohibited from frequenting any of the areas in the camp or attending any of the recreational facilities available.

(a) Barracks and Hutments. - Two different types of buildings, wing-type barracks and hutments, were used in the Hanford Camp to provide sleeping quarters for the majority of men and women living in the camp. The barracks were of a two-wing type for women, and of a four-wing type for men. A total of 777 barracks and

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huts ments, operated under subcontract by the Olympic Commissary Company and capable of accommodating 39,050 workers, were erected in Hanford Camp, although only 770 were utilized for housing (See App. B 14). Approximately 125 Army pyramidal-type tents with wooden floors and sidewalls were used as temporary sleeping quarters for male workers employed in the construction of Hanford Camp until more permanent quarters could be provided. During the last week of August 1943, the maximum of 834 workers was housed in tents which were later abandoned as barrack space was made available.

1. Barracks (See App. A 38, B 14, B 15, and B 56). - Construction work began on 8 April 1943 on the first group of ten white men's barracks. Construction of the first group of white women's barracks started on 20 June 1943. On 12 June 1943, a camp to accommodate 1000 colored male workers was proposed, and construction of five men's barracks was started on 17 June 1943. Soon after construction was started on these units, the proposed number of colored men's barracks was increased to 21. Colored men's barracks were segregated from the white men's barracks and provision was made for the location of colored recreational facilities in this area. The first colored women's barracks were authorized on 18 August 1943 and construction was begun immediately. In all, eight colored women's barracks were authorized, only seven of which were construsted as it was found more economical to adapt three colored men's barracks for use by women. The total of 151 men's barracks capable of housing 24,319 workers was completed by 19 February 1944. Of these, 110 barracks were used to house white employees. The remaining 21 units were used to house

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colored employees, except for three barracks which were later used to house colored women, and one unit which was used as a community building for colored employees. A complete barrack unit, as originally designed, contained 100 sleeping rooms which provided housing quarters and toilet facilities for 191 men. The total of 64 women's barracks capable of accommodating 4480 employees was completed by 27 May 1944. Through the use of three of the colored male units for colored women, the conversion of a barrack into a recreation hall, and the use of another barrack by the Women's Army Corps, a total of 4897 accommodations was finally provided. Seven units, plus the three colored male units, were used to house the colored female employees, and 56 barracks were assigned to white female employees. Speed in barrack construction was emphasized throughout all stages of the camp's progress. Original building schedules called for a total of four barrack units to be completed per week. This schedule was met, and in a comparatively short time was increased to ten units per week. As fast as the units were completed, they were utilized by the incoming workers. Construction of the last group of barracks was completed by 27 May 1944. Although compilations of start and finish dates of barrack construction indicate a considerable lapse of time (See App. B 18), the barrack groups were made ready for occupancy within a week to ten days after the start of construction. Delays in the receipt of critical heating and ventilating equipment were responsible for prolonging these completion dates. The barracks were heated and ventilated by blowers in combination with steam coils and evaporating units.

2. Apartments (See App. A 36). - As

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construction progressed, it was found that labor was being drained away from the process areas for use on Hanford Camp. To alleviate this condition, a prefabricated type of housing unit was used. On 19 January 1944, 560 single huts, 40 feet long by 16 feet wide, constructed of plywood and Celotex, each unit housing ten men, were purchased. This order was placed with Pacific Huts, Incorporated, of Seattle, Washington, and was later altered to cover the purchase of 420 additional units. Double huts were made by combining two units. A total of 320 double huts and 340 single huts was erected. Work was started on the first group of hutment bathhouses on 11 February 1944, but erection of hutments did not follow until 27 February 1944. The completion of these units was dependent upon the rate at which hutments could be delivered to the plant site. All units were erected by 18 July 1944. During the first part of June 1944, some of the 10-man and 20-man huts were converted to house 11 and 22 workers, respectively, in order to accommodate the peak construction population. The hutment area, comprised of a total of 320 double huts and 272 single huts with 44 bathhouses, was erected to accommodate 10,052 workers. The accommodations were reduced by 198 because of the necessity of using some of the hutment space for service buildings. Of the total, 252 11-man units were used to house colored male employees; the remaining huts were devoted to white male employees. A number of these huts were erected at various locations in the Hanford Camp area and the other temporary construction areas to serve as offices, warehouses, shops, and commercial facilities. Heating was supplied by coal and wood burning stoves centrally located in each unit. Cooled air was supplied

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during hot weather by "evaporation coolers."* Use of these units eased the strain on the construction force and effectively increased the number of workers available for actual plant construction. Consideration had been given to the use of prefabricated dwellings prior to the actual start of Hanford Camp construction but, at that time, the plywood necessary for construction was classified as an extremely critical material because of the heavy demands for hutments in the Pacific areas.

(b) Trailer Camps (See App. A 37, B 16, and B 56). - The building of a trailer camp at Hanford was of extreme importance as a large number of workers made their homes in trailers, taking their families with them from one war construction project to another. The original camp, having a capacity of 480 trailer lots, continued to expand throughout the major part of construction, finally reaching a total of seven camps, operated by the Prime Contractor, with a combined capacity of 3639 individual trailer lots (See App. B 16), all but 45 of which were occupied during the peak period. At the peak, 12,008 persons lived in the trailer camps.

1. Trailer Lots. - Trailer camp construction work was started on 20 May 1943. The demand for trailer camp living facilities was reflected by the immediate filling of trailer lots before lighting and bathhouse facilities could be provided. Before Camp No. 1 was complete, it was apparent that this camp would be inadequate for the anticipated needs, and plans were made for a second camp. While Camp No. 2 was being constructed, it became necessary to place incoming trailers in temporary locations, provided with necessary facilities.

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In all, six of these temporary camps, averaging 140 trailer lots each, were provided during this time. The main trailer camp, composed of five camps (Nos. 1 through 5) for white families, contained approximately 300 acres and could accommodate 3298 trailers. Upon the completion of Trailer Camp No. 2, the size of the individual trailer lots was reduced from 40 feet by 40 feet to 25 feet by 40 feet in order to increase the number of lots per acre. Further expansion of the main trailer camp was restricted by the terrain southwest of the camp and by the temporary buildings and facilities on the other three sides. Construction of a sixth white trailer camp, occupying 88 acres and designed to accommodate 2000 trailers, begun 10 March 1944 and only proceeded to the point where complete accommodations were provided for 265 trailers. When sewer and water connections for an additional 268 lots had been completed, the demand for accommodations indicated that no further space was needed. Construction of a trailer camp for colored families, accommodating 78 trailers, was begun on 18 February 1944 and was completed 1 June 1944. All trailer camp construction was completed on 2 August 1944.

2. Trailer Services. - Trailer service buildings--trailer canopies, bathhouses, ice houses, coal storage buildings, playgrounds, trailer camp office and warehouse, and dog pound--were constructed as time and labor permitted, to serve the occupants and to provide for the efficient operation of the trailer camps (See App. A 38-40). Trailer service facilities included water lines, steam lines, electrical lines, telephones, sewers and septic tanks, general grading and landscaping, roads, and walks. The trailer

camp gave every appearance of being a modern well-planned miniature city, with all streets parallel to each other and perpendicular to the main avenues.

(3) Facilities. - During the life of the Hanford Camp, a total of 1178 buildings and nine service facilities (See App. B 17) were used to house, feed, and provide necessities for construction workers and their families. Although the mess halls and recreation halls were operated under subcontract by the Olympic Commissary Company, the majority of the commercial and recreational facilities provided at Hanford were leased to private operators by the Prime Contractor (See App. B 18). Initially, the existing buildings of the town were used for commercial facilities. Existing store buildings were stocked to provide grocery store, clothing store, and other similar services to the inhabitants of Hanford at the earliest possible time. Because of the urgency of plant construction and the shortage of labor during the first nine months of the occupation of Hanford, only those facilities considered absolutely essential were provided. As permanent plant work progressed and the construction force increased, commercial and service facilities were expanded to meet the additional requirements. Eventually, Hanford included stores of sufficient variety and number to satisfy all the essential needs of the population. At no time were luxury items available in quantity at the camp. Recreational facilities were provided when they appeared justified by possible reductions in the cost of hiring and keeping workers at the camp. Most of the commercial facilities were centrally located in the triangular-shaped section between the

main trailer camp and the administration and service area. Additional units were provided later for the outlying sections, when the camp reached its maximum population. The construction of mess halls, commercial store buildings, and buildings housing recreational facilities was carried on at the same time as barracks and hutment construction. Necessary feeding facilities were constructed on the basis of one mess hall for 4000 persons. Many of the commercial store buildings and recreational facilities were not started until barracks and mess hall construction was well under way. In almost all cases these buildings were occupied long before the final completion dates (See App. B 19), as these dates reflect late deliveries of heating, ventilating, refrigerating, and cooling equipment.

(a) Commercial Facilities (See App. A 41-52, and B 56). - All buildings for the housing of commercial and recreational facilities, as well as churches, in the Hanford Camp area, except for a few minor concessions, were provided by the Government. A total of 49 buildings were provided, six of which were rehabilitated existing buildings. In several cases, larger buildings had to be constructed to take care of the volume of business the camp produced. Prefabricated huments were used for the smaller commercial facilities. Among the commercial facilities provided were eight mess halls, two garages and service stations, two combined store buildings, a laundry, a bank, a post office, and a commercial bus station.

(b) Recreational Facilities (See App. A 53-56, and B 56). - The fact that no recreational facilities were available in the vicinity of Hanford, together with the large population

assembled and the estimated two year duration of the job, prompted the construction and operation of limited recreational facilities, such as theatres, recreation halls, bowling alleys, an auditorium-gymnasium, and various outdoor facilities.

(c) Community Facilities. - The Hanford Camp was afforded many community facilities such as schools, a hospital, churches, fire and police protection, and a library.

1. Schools (See App. A 57, 58). - After a conference between representatives of the Project and the State Superintendent of Education, the State of Washington accepted full responsibility for providing school facilities. Inasmuch as the Project acquired and maintained control of all real estate, the Government furnished the buildings, including fixed furniture. The State Department of Education staffed the schools and accepted the responsibility for their operation. It was necessary, however, that state funds allocated for this operation be supplemented by Lanham Act Funds (See App. C 22). The existing Hanford school was located on the Hanford-White Bluffs Road and had an enrollment at the inception of the Project of approximately 65 students. The Fall Term opened 14 September 1943 with an enrollment of 560 students and a staff of 18 teachers. As enrollment increased, additional temporary buildings were constructed adjacent to the existing school. During the 1943-1944 school year, 1891 students were enrolled and the staff had been increased to 38 teachers. The Hanford school was closed on 13 February 1945. High school students attended the Columbia River High School in Richland, and were transported daily from Hanford by bus. A Nursery School was

opened on 20 March 1944 for children between the ages of two and six, and a Child Care Center was added on 12 June 1944 for children from six to twelve years of age. Operation of the Nursery and Child Care Center was continued through 10 February 1945, with an over-all attendance of 15,324.

2. Hospital and Medical Facilities (See Book 1, Vol. 7). - The isolation of the Project and the large population necessitated the establishment of hospital facilities that would afford complete surgical and medical services for all persons on the reservation during the construction period. At the peak, in order to meet construction schedules, it was necessary to have a population at Hanford of around 50,000, for whom community medical facilities were required; pre-employment examinations were also provided for more than 91,000 applicants, a problem requiring expansion of all medical facilities in order to care for such a fluctuating population.

a. Types of Facilities. From an initial establishment in April 1943 of a first aid station, medical facilities grew to include the following:

1 General Hospital, capacity	160 beds
1 Convalescent (and Isolation) Hospital, capacity	250 beds
Total Hospital Capacity	410 beds

The General Hospital contained a first aid station, in addition to examination and treatment rooms and surgical facilities, as well as housing staff offices in a total space of 57,420 square feet; the Convalescent Hospital covered an area of 69,000 square feet. The

construction of both hospitals was wood frame, plasterboard interior and exterior, celotex ceilings, wood flooring with some asphalt tile floor covering, and roll roofing, mineral coated. Brick firewalls were provided, ventilation was by means of roof coolers and fan ventilators, and heating from steam radiators.

As these facilities were constructed, they were immediately utilized so that regular hospital facilities were available at Hanford to construction workers and their families in July 1943, with a total capacity of 30 adult beds, 4 pediatric beds, and 8 cribs, and by June 1944, capacity had increased to 116 beds. In September 1943, an out-patient clinic was opened for treatment where hospitalization was not required. In the latter part of 1943, barracks units were utilized as temporary sick bays to relieve hospital congestion, and a special isolation unit was established, such temporary expedients being

utilized until an infirmary and public health building was constructed and occupied in June 1944. This latter building, which included a sick bay, an isolation unit, a public health section, a psychiatric unit, and a morgue, was operated in conjunction with the hospital. The peak medical employment during construction reached 610 persons and included 31 doctors, 2 dentists, and 168 nurses (See App. B 20).

5. Churches (See App. A 51-52, and B 26). - Protestant church services were originally held in existing town buildings, but as the camp expanded, additional space had to be provided. A one-story, wood-frame annex was constructed for the United Protestant Church and was attached to the existing church building. Catholic Church services were held in a canvas tent during the major

part of construction. The tent was provided with a wooden floor, sid walls, and benches, and steam heat was installed. When the auditorit was completed, church services were held in this building. Colored church services were held in one wing of a barrack. The second floor of the existing Grange Hall building and Masonic Hall building were remodeled and used part-time for other church functions.

4. Fire Protection. - Hanford Camp was composed entirely of temporary type, wood-frame buildings and was, therefore, highly inflammable (See pp. 5.8 - 5.9). This, together w the arid climate and high winds prevalent, enjoined the establishment of complete fire protection facilities. On 20 May 1943, an experienc Fire Chief, who reported directly to the Fire and Patrol Supervisor, was appointed. From then until 1 July 1943, the department was dependent on patrolmen for a great part of its manpower. Department -

headquarters was first established with Patrol in an existing house near the Hanford School. Permanent quarters (See App. A 68) were occupied on 28 October 1943 and contained offices, supply storage, sleeping quarters, and space for mobile fire equipment (See App. B 8. On 24 June 1943, a Fire Inspection Division was organized, with responsibility to inspect, detect, and correct, insofar as possible, al fire hazards, fire causes, or conditions that would accelerate fires after their inception; to make necessary recommendations and suggestions for eliminating or minimizing hazards; and for the installation of all fire fighting equipment. The maximum number of alarms per month, 66, occurred in May 1944 (See App. B 22).

5. Patrol (See App. A 64). - The large and

varied population concentrated at Hanford posed the question of law enforcement (See Vol. 1). Accordingly, the Hanford Patrol was established on 1 May 1945 and operated until the construction camp was abandoned.

6. Library (See App. A 65). - A one-story, prefabricated building was erected opposite the Hanford Post Office to house the Hanford Camp Library. The library opened 18 April 1944 and was operated by the Hanford Engineer Works Employees' Association until 1 February 1945. During this period approximately 46,500 persons used the facilities and 17,000 books were circulated.

e. Construction Delays. - The chief causes for delays in the construction of Hanford Camp were labor shortages and difficulties in obtaining critical materials. Considerable difficulty was encountered in the procurement of special items of equipment, such as 100-horsepower boilers, hot water heaters, toilet fixtures, fans, heating coils, cooling units, refrigeration units, and mess hall equipment, in the quantities required for the construction of Hanford Camp. Because of these shortages of materials, it was often necessary to use barracks for several months before complete heating and toilet facilities were installed.

f. Construction Expedients. - Whenever and wherever possible, expedients were employed to increase the tempo of camp construction and to keep pace with mounting demands for living accommodations. Most of these were not unusual and could be considered good construction practices. A discussion of the most noteworthy expedients follows:

(1) Field Design. - By handling design at the construction site, a minimum of time was required for the preparation of drawings, and the time lost in the transmittal of information and drawings was eliminated.

(2) Standardized Design. - The use of standardized design for barracks, mess halls, and trailer service building minimized the number of drawings to be prepared, cut down the erection time, and permitted advance orders of standard equipment.

(3) Special Construction Methods. - In the construction of the camp buildings, a certain amount of prefabrication was used. The framework for nearly all the buildings was pre-cut and marked at a central fabrication area and delivered to the building site as required. Small trusses, door and window frames, and small items were fabricated at one central location by special crews. Items of plumbing, piping, electrical, and mechanical units were assembled on a production line basis. Early in 1944, it was decided to abandon the four-wing type barrack design and to adopt, instead, prefabricated huts ments and conventional centralized bathhouses. This resulted in a reduction of man-hours and critical building materials required for housing construction; a reduction of temporary construction costs; and an increased salvage value of the facilities.

(4) Materials. - To overcome delays, a bill of material and equipment for ten barracks and one mess hall, as complete as possible, was kept on order at all times to maintain a working stock. This pre-ordering was greatly responsible for a shortening of the construction period for later units. Government transfers of material and

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equipment played a large role in the early completion of Hanford Camp. These made possible the immediate delivery of certain critical equipment which otherwise could not have been delivered for several months because of the considerable fabrication time required.

(5) Subcontracts. - A number of subcontracts were awarded for certain phases of construction work in the Hanford Camp area. These awards were made primarily for the following reasons: to obtain specialized labor and supervision; to eliminate delays in the procurement of special construction equipment; to make use of extensive organization and personnel of specialized contractors; and to complete each phase of work in the shortest possible time (See App. B 23).

5. Progress of Construction. - Every effort was made to rush completion of the necessary living facilities which had to be provided at Hanford before permanent plant work could be started. Housing construction was given precedence over all other work in Hanford as it was realised that the number of employees that could be immediately hired was directly affected by the number of living accommodations that could be provided.

(1) Schedules. - On 4 April 1943, a schedule was prepared to cover the scope of the Hanford Camp construction known at that time, as well as a labor forecast to meet this schedule. The original schedule called for completion by 1 December 1943, using a peak force of approximately 2900 men (See App. B 24, 25). Both the schedule and labor forecast were revised on 30 September 1943, because of changes in scope of the work. It was impossible to establish a

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firm construction schedule and labor forecast as the size of the Hanford Camp was continually being revised upward.

(2) Force. - A peak force of approximately 5300 workers was employed in camp construction on 1 December 1943 and a force of 90 per cent of the peak was maintained over the five-week period from 1 November 1943 to 7 December 1943 (See App. B 25). In order to obtain a sufficient force and to keep pace with the increased demand for living facilities, it was necessary to curtail permanent construction work in the production areas from the latter part of September to the first part of December 1943. More than 2000 carpenters were required for barrack construction during the peak months.

(3) Rate of Construction. - The progress of construction for the Hanford Camp was very erratic (See App. B 26) entirely because the scope of camp work was ever changing. However, construction work was essentially complete by the end of July 1944, at which time 98 per cent of the known work was finished.

5-3. Auxiliary Construction Camp (See App. A 5, 66). - The auxiliary construction camp, called the 3000 Area, was built to house construction employees working in the Metal Fabrication and Testing Area and Richland Village, but was never used for that purpose since it was found more economical to transport the necessary workers to these areas from Hanford. This camp was to provide for future needs also, since, at the time of its construction, it was anticipated that a considerable number of construction workers would be required after the abandonment of the Hanford Camp.

a. Description. - This camp was constructed along the east

side of the Richland-Hanford road, approximately midway between Richland Village and the Metal Fabrication and Testing Area. The camp site is rectangular-shaped, 800 feet wide by 2000 feet long, and contains five four-wing type men's barracks and a two-wing type women's barrack capable of accommodating 944 men and 70 women, respectively. A mess hall with an attached warehouse was provided to feed the population (See App. B 27).

b. Facilities. - The camp afforded heating and cooking facilities; electric power and lighting, transmitted from Richland; sanitary sewers with septic tank and settling basin; telephones connected through the Richland exchange; roads; and a bus loading lot.

c. Construction. - The construction of the auxiliary construction camp was assigned to the Contractor's Division Engineer in charge of the Metal Fabrication and Testing Area. Standard barrack, mess hall, and service facility design was adopted, identical with the design for the Hanford camp buildings and facilities. Work was started on 10 June 1943, but was stopped during the middle of July after approximately 50 per cent of the building structures had been erected. At this time, it was felt there would be no need for these accommodations. Work was not resumed until February 1944 when activity for the recruitment of Spanish-American labor was started (See Par. 4-2). The barrack buildings, mess hall, and service facilities were essentially ready for occupancy by the latter part of March 1944. Prior to the start of construction work, the camp area was graded and stabilized with a six- to eight-inch layer of packed sand and gravel.

d. Use. - The Peace Housing Department utilized two of the

men's barracks from 17 November 1943 until 24 March 1944 for the overnight lodging of new employees who were unable to complete employment sign-up during the day. In that period, 7409 white male recruits were housed. Two additional barracks were used from that time until 1 October 1944, for emergency overnight housing caused by fluctuations in recruitment. On 1 July 1944, part of the camp was taken over by the Area Engineer to house and feed the Military Police assigned to the Project. Camp maintenance was handled by the Contractor's Construction Division until the Contractor's Operating Department assumed its duties. At the request of the Area Engineer, one barrack wing was converted to provide an infirmary and examination room for military personnel. A garage was provided for servicing Military Police automotive equipment. The last barracks were taken over by the Military Police on 14 January 1945.

5-4. Construction Plant. - Because of the widespread locations of the construction areas for the Hanford Engineer Works, it was not economical to consolidate the necessary temporary shops and facilities at one location. This fact, together with the scope of the construction involved, was responsible for the number of similar shops and of temporary facilities required in the construction of the plant. The lack of shop facilities near the plant site, and the need for fabrication of classified materials, made it necessary to establish shops equipped with machinery to do all types of work, including those which normally would be performed by existing local "job shops."

a. Central Shops (See App. A 6, 67). - As the bulk of the construction work involved was in the construction of the Pile and

Separation Areas, a site was selected on the Hanford-Cold Creek road (See App. A 7), centrally located with respect to these areas, for the establishment of the Central Shops. Here were established the craft administration offices, the office of the Division Engineer for general facilities, Area Engineer's field force offices, layout office, inspection office, transportation garage, machine and sheet metal shops, crane repair and riggers loft, electric shop, test laboratories and shops, fuel storage facilities, paint shop, and warehouses (See App. B 28).

b. Graphite Shop (See App. A 68, and B 56). - The graphite needed for the Pile matrix was received in the form of bars, approximately five feet in length. Since very close tolerances were required in the dimensions of the finished blocks, it was necessary to provide a special shop for machining the graphite. This building, erected at the western edge of Hanford Camp, had extensive facilities for shaping, cutting, boring, facing, and testing the graphite. Inasmuch as the aluminum tubes had to be fitted through the blocks, it was extremely important that the holes bored in the graphite be exactly the same in location and size. All dimensional testing was done by electric gages. A railroad siding was built to the shop and a covered unloading platform was installed for the special shockproof, dustproof trucks used to transport the graphite to the Pile Areas.

c. Concrete Pipe Shop (See App. A 8, 68). - The Concrete Pipe Fabrication Shop (See App. B, Building #11) was located at White Bluffs, adjacent to existing rail facilities. A total of 131, 358 linear feet of 24- to 48-inch concrete pipe was produced.

d. Masonite Shop (See App. A 8). - Near the pipe shop a building (See App. A 8, Building #8) was erected for the fabrication of masonite panels to be installed in the Pile (See Par. 6-3). Approximately 7,500,000 sq. ft. of 1/8 inch thick masonite was processed in this plant. To fabricate the panels to the close tolerances desired, it was necessary to install precise woodworking equipment susceptible to fine adjustments. It was also necessary to install large presses for the lamination of the masonite.

e. White Bluffs Fabrication Shop (See App. A 8, 70). - The structural steel "T" sections to be used in the Pile units (See Par. 6-3) were of such great size that it was found impossible to procure them from usual sources. It was necessary to purchase the steel plate and fabricate the sections on the site. Accordingly, a shop (See App. A 8, Building #1) was constructed, in the same area as the masonite shop, for fabrication of the "T" sections. Because of the size of these sections, it was necessary to build a railroad siding into the building in order to move them.

f. Concrete Plant (See App. A 71). - In order to obtain the 750,000 cubic yards of concrete placed during construction, a concrete plant had to be provided.

(1) Location. - Because of the wide separation of areas, an independent concrete plant was set up in each area. Five such plants were in use, located in the Pile and Separation Areas. A two-cubic-yard batch plant was set up in Richland where the concrete was batched directly into Transit-Mix trucks.

(2) Batching Equipment. - All batching plants were

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similar in arrangement. Material was dumped into four bins located under the railroad tracks. A 30-inch endless belt, under the bins, conveyed the aggregate through a tunnel to bins over the mixer. A revolving band, at the upper end of the belt, could direct the aggregate to any of the four bins over the mixer. A total of 18 concrete pumps was used to pump concrete from the mixing plants to the construction sites.

(3) Aggregate Plants (See App. A 78). - Soil tests throughout the area indicated that the aggregate and sand needed for the concrete mix could best be supplied at sites near Haven and Hanford (See App. A 9). Aggregate plants were constructed at these sites and were equipped with rail sidings.

(a) Haven Plant. - The Haven plant was located near the Riverland Yards of the Chicago, Milwaukee, St. Paul and Pacific Railroad located at Vernita and was capable of producing 350 to 450 tons per hour. A tunnel was constructed under the stock piles through which a conveyer belt carried the aggregate up and into railroad cars. This plant was operated until 24 June 1944.

(b) Hanford Plant. - The Hanford plant, located just northeast of Hanford Camp, was equipped to produce 500 to 600 tons per hour. At this plant an average of 52 cars was loaded per day during July 1944. Cars were loaded by the same methods as used at the Haven Plant.

(c) Hauling Equipment. - Normally, four locomotives were used to haul concrete aggregate. Each locomotive was capable of hauling 1500 tons over the grades in the various areas.

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There were 169 aggregate cars on the Project, all of which were in use at the peak of concrete production.

g. Process Area Temporary Construction (See App. A 10-19). - A standard design was adopted for most of the temporary shops, buildings, and facilities located in the process areas under construction. Following is a list of typical temporary construction units common to the Pile and Separation Areas: Area Engineer's Field Office, Contractor's Division Engineer's Office, Layout Office, Clerk Office, Safety Office, First Aid, Labor and Concrete Office, Paint Office, Earthworks Office, Machine-Millwright and Sheet Metal Shop, Electrical Office and Shop, Transportation Office and Garage, Rigger Office and Loft, Pipe Office and Shop, Carpenter Office, Shop and Lumber Yard, Reinforcing Steel Office and Shop, Temporary Building, GE Warehouse, Pipe Warehouse, and Electrical Warehouse. For security reasons, each Pile Area was provided with administrative offices, craft shops, and warehouses, separate from those required for the other facilities in the area. Additional offices, shops, and warehouses were also required for the construction and maintenance of Hanford and the Metal Fabrication and Testing Area, as well as for the other temporary plant-wide facilities such as water systems, railroads, roads, electric power, telephone, sewers, and septic tanks. A total of approximately 700 temporary buildings and structures was erected and 50 existing buildings remodeled for construction use, exclusive of the construction camps (See App. B 29).

5-8. Temporary Utilities and Services.

a. Roads. - Before work could be started on the permanent

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plant road system, a certain amount of maintenance work had to be performed on the existing plant roads in order to carry safely the increased volume of plant traffic. Main Project access roads and plant site thoroughfares were reshaped and widened in several sections. Heavily traveled gravel-surfaced roads, such as the Hanford-Cold Creek and the White-Bluffs-Cold Creek roads (See App. A 9), were given a palliative treating using MC-2 road oil. Prior to the layout and construction of permanent access and intra-area roads for the Pile and Separation Areas, temporary roads had to be provided for the transportation of workers and construction materials. In several instances, existing ranch roads run through the area and connected with improved country roads. These were widened and maintained for access purposes until the permanent inter-area access roads had been completed. In the production areas, wider temporary roads were constructed to alleviate congested traffic conditions. Many of these roads were laid out on approximately the center-line locations of permanent intra-area and plant-wide roads, enabling them to be used later as bases for permanent roads. The stabilization of the temporary construction areas eliminated the building of many miles of temporary roads and walks, and greatly eased transportation problems. Temporary roads were constructed of compacted sand and gravel eight to twelve inches thick, varying from 16 feet to 50 feet in width. During the summer months, they were sprinkled to eliminate dust. Pit-run sand and gravel, obtained from the area building excavations and local borrow pits, were used for road building and stabilization purposes. Additional temporary roads were constructed in the Central

Shops Area, White Bluffs, Hanford, and Richland, as well as at inter-area locations, to serve construction facilities at these points. Most of these were built by the Project's Earthworks Department. Approximately 94 miles of temporary roads were constructed, improved, or maintained on the plant site during the construction period (See App. B 30).

b. Walks. - Temporary walks were provided in construction and camp areas to safeguard pedestrian traffic. Bituminous-surfaced walks were laid only in the Hanford Camp and Central Shop areas (See App. A 73). In all other areas, packed sand and gravel walks varying from four to five inches thick and from four to ten feet wide were installed. Throughout the areas 63.6 miles of walks were constructed (See App. B 31).

c. Railroads. - Because of the widespread construction locations for the plant and the volume and types of materials involved, railroads were an important method of transportation. Rail transportation direct to the working areas would minimize the rehandling of construction materials and equipment. Therefore, immediate steps were taken to put the existing tracks of the Chicago, Milwaukee, St. Paul and Pacific Railroad in condition for the heavy service anticipated (See Par. 5-5). Design for permanent inter-area railroads was also started so that these tracks could be used for construction purposes. On 12 April 1943, approximately three months before existing railroad properties were acquired by the Government, the Prime Contractor obtained permission from the Chicago, Milwaukee, St. Paul and Pacific Railroad to begin such repairs as were thought necessary.

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on the line from Vernita to Hanford (See App. A 8). A short time after this work had been started, a subcontract was awarded to the Guy F. Atkinson Company for the construction of the permanent railroad system and the temporary railroad facilities known at that time to be required (See Par. 7-4). Approximately 51.62 miles of temporary railroads were constructed by this subcontractor. This total included a four-track temporary classification yard, of 225-car capacity, at Riverland Yards (See App. A 74, and B 56); rail service to the fabrication areas of the major subcontractors; rail facilities to and from the railroad ballast and concrete aggregate plants; cement and aggregate storage and unloading tracks at each central concrete mixing plant in the Pile Areas and in the East and West Separation Areas; miscellaneous spurs in all areas, except the Metal Fabrication and Testing Area, for unloading construction

material and equipment; and miscellaneous wyes, set-out tracks, passing tracks, by-passes, and repair tracks required for handling this volume of traffic. Work on the above facilities was started by the subcontractor during the latter part of April 1943 and was essentially complete by 15 January 1944. Sixty pound to eighty-five pound used rail and No. 8 turnouts were procured for this work through the Chief of Engineers' Office, United States Corps of Engineers.

d. Water Supply (See App. B 58, pg 96). - Water supply facilities existing at the start of construction were not sufficient to furnish water for construction purposes. The three townships of White Bluffs, Hanford, and Richland, with populations of approximately

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200, 125, and 250, respectively, had their own individual water systems (not interconnected) that supplied water to commercial facilities and homes. In addition to these systems, numerous small wells had been drilled throughout the area to provide drinking water for the individual outlying farms and ranches. Two irrigation systems, the Richland Irrigation District System and the Priest Rapids Irrigation District System, using water from the Columbia and Yakima Rivers, were in operation to furnish water to farms, orchards, and ranches in the vicinity of these three small communities.

(1) Separation Areas and Central Shops. - It was determined that during the construction period, the Separation Areas would each have peak water requirements of approximately 500 gallons per minute. Since the peak requirement for the two Separation Areas would not occur simultaneously, it was estimated that the existing McGee Artesian Well (See App. A 16) which was capable of a sustained flow of approximately 900 gallons per minute over a period of time, could supply water to these areas. Consequently, a line paralleling the Cold Creek Road was run from the McGee Well to the Central Shops, and to the Separation Areas. This line included booster stations, floating water tanks, and ground and elevated water tanks. A line running from the Allard Pumping Station (See App. A 16) on the Columbia River to Central Shops was also connected to this system to serve as a reserve in case the McGee Well should fail. Work on the McGee System started 26 September 1943, and was completed in June 1944.

(2) Pile Areas. - It was determined that, during

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construction, the Pile Areas would each require a maximum of approximately 3000 gallons of water per minute. Since this requirement could best be supplied by the Columbia River, marine pumping stations were provided and temporary water lines constructed throughout the area. After December 1945, all service water lines throughout the Project were chlorinated. Throughout the construction period, drinking water was distributed to the areas principally by water trucks and barrels.

e. Power (See App. B 56, pp. 86-87). - The existing substations at Hanford, Richland, White Bluffs, and Allard provided all early construction power until additional substations could be installed. Construction power for the Pile and Separation Areas was obtained from the existing 66-kilovolt transmission lines of the Pacific Power and Light Company and the Priest Rapids Irrigation District by building approximately 18 miles of lines to these areas.

f. Fences. - In the construction of the Hanford Engineer Works, approximately 50 miles of temporary fences were required for the construction areas, various inter-area locations, and required off-plant locations. This construction was made necessary by the classified nature of the work and the necessity of controlling traffic in and out of the areas.

g. Sewers and Septic Tanks. - For the disposal of sanitary sewage 46.8 miles of temporary sewer lines, varying in size from four inches to 30 inches, and 80 septic tanks of various sizes were installed (See App. B 32).

h. Steam Lines (See App. B 56, p. 87). - Approximately 38.5 miles of temporary plant-wide steam lines, varying in size from one

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to 12 inches were required in the construction of the Hanford Engineer Works. A total of 23 semi-permanent boiler houses (18 in Hanford Camp, 4 in Central Shops, and 1 in 3000 Area) were erected to operate the steam system. These buildings were one-story, wood-frame, post and girder construction, with gypsum board siding and roll roofing, while the soft water storage tanks were wood stave. The 23 boiler houses contained 115 boilers from 30-550 HP (total rating 26006 HP), with portable boilers from 12-100 HP and 6 steam locomotives connected in parallel (1500 HP) supplementing the fixed units.

i. Telephone Lines. - Temporary telephone lines were provided under direction of the Signal Corps and 4000 telephones were put into service, utilizing as far as possible the existing lines of five companies. Switchboards set up in Pasco, Richland, Hanford and Central Shops provided 1110 lines (975 being at Hanford Camp). A repeater station on the main trunk line north of the 300 Area was installed to improve transmission.

5-6. Off-Area Hotel, Dormitory, and Rooming Facilities. - During the early period of construction when offices were located temporarily at Pasco, Washington, it became necessary to provide many of the workers with temporary living quarters, as the hotels and rooming facilities in the Pasco-Kennewick community were inadequate. This condition existed even after the completion of the Hanford Camp. As new employees arrived in Pasco for work on the Project, they were confronted with the problem of obtaining sleeping accommodations until they could report for work and be assigned to permanent living quarters. To alleviate this condition, Project forces improved or converted leased,

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rented, and loaned properties in order to fit them for temporary living and working facilities.

a. Little Pasco Camp (See App. A 75, B 56, ~~C 65~~). - In the early part of March 1944, general remodeling work was performed by Project forces on eight existing barracks buildings and two detached bathhouses which were loaned to the Hanford Engineer Works by the Army Reconsignment Depot for the immediate housing of incoming white and colored male workers. These buildings were located 2.5 miles northeast of the city of Pasco, on the Army Reconsignment Depot Reservation. In addition to the 10 buildings referred to above, a mess hall (20' x 100' x 11'), a fire station (20' x 100' x 11'), and an overflow barracks (Pacific Hut style - 16' x 80' x 9') were set up on the Reconsignment Depot Reservation, while a Reception and Information Building (Pacific Hut style) was located in the city of Pasco.

b. Bunkhouses.

(1) Duck Pin Inn. - The Austin Building in Pasco was leased and converted into a bunkhouse for overnight housing purposes. Conversion work consisted principally of installing toilet and washroom facilities, additional lighting, heating, and double deck steel bunks. The bunkhouse was opened on 24 April 1943, and was closed on 24 March 1944, upon the opening of the Little Pasco Camp, after housing 17,681 white male recruits. The bunkhouse was then used to house colored recruits from 25 March 1944 to 21 July 1944, housing in that period 5488 colored workers.

(2) Colored Bunkhouse. - The Jewell Building in Pasco

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was leased and converted into a bunkhouse for the overnight housing of colored personnel. General inside remodeling, which included the installation of additional toilet and washroom facilities, lighting, coal-stove heating, partitions, and painting, was performed by Project forces. The bunkhouse was opened 28 July 1943 and closed on 24 March 1944 when the Duck Pin Inn was used to house colored recruits. During this period a total of 3708 colored workers was housed on a one-day basis.

c. Dormitories. - On 24 April 1943, the Strand Hotel in Prosser was leased by the Project to accommodate women employees of the United States Corps of Engineers and the Prime Contractor. Only minor jobs of painting, paper hanging, carpentry, and plumbing were required before occupancy. The building was used until September 1943

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when living accommodations for women at Hanford Camp were completed.

B-7. Rehabilitation of Plant Site Tract Houses.

a. Family Type Houses (See App. A 76). - There was a total of 468 houses in areas "A" and "B" (See App. A 16) of the Hanford Site at the time it was acquired by the Government. Because of the shortage of family housing facilities in the surrounding towns, it was decided to make use of all residences which could be remodeled within the allowable expenditures, and which were not located in a construction area. In the early part of May 1943, a survey of these houses was initiated and reports were prepared containing rehabilitation recommendations for all houses in both areas. Of the total, 220 houses were rehabilitated for family use or eligible Project personnel; 14 of the existing houses were remodeled as bachelor quarters;

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and approximately 55 houses were used as field offices and storage warehouses. Most of these buildings were located in the Hanford-White Bluffs community. After the evacuation of houses in areas "A" and "B," the less desirable structures were dismantled, at the request of the Area Engineer, by Project forces; 68 residences were sold by the Government; and the remaining houses were boarded up and padlocked.

b. Bachelor Quarters (See App. A 77). - At the start of the Project, it was necessary to provide housing facilities on the plant site for key construction personnel who were subject to 24-hour call. Therefore, a number of existing residences were converted into bachelor quarters prior to the construction of barrack facilities. A total of 14 units, varying in capacity from 6 to 22 persons each, and housing a total of 140 male employees, was provided for this purpose (See App. B 33). Most of these quarters were located in the Hanford area, and were occupied by construction personnel, until the abandonment of Hanford Camp. As housing facilities were provided in Richland for the original occupants, other persons of supervisory capacity were housed in these units until permanent quarters could be provided at Richland. These buildings were furnished with standard type furniture and kitchen equipment, the same as was provided in the rehabilitated family type residences. Rental for bachelor quarters was collected by the Olympic Commissary Company, housing subcontractor, who furnished necessary daily janitorial services and linens.

5-8. Miscellaneous Temporary Construction. - A number of

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temporary buildings and facilities were constructed outside of any specific area which, directly or indirectly, contributed to the construction of the entire Project and not to one single area (See App. B 34). Most of these buildings were located in the Hanford-White Bluffs vicinity; however, on a few occasions off-plant work was performed under this classification at Pasco and Little Pasco. Listed below are some of the typical temporary construction items:

1. White Bluffs. - Blacksmith shop, receiving warehouses, miscellaneous storage warehouses and yards, a Division Engineer's office, fire station, and necessary field offices.
2. Leamer Spur. - Miscellaneous receiving, unloading, storage, excess, and salvage warehouses and yards; and necessary craft and field offices.
3. Hanford. - Receiving and storage warehouses; utility division offices, shops and warehouses, instrument shop and warehouse; miscellaneous craft and field offices, boys' and girls' work huts, Red Cross hut, Women's Army Corps Post Exchange, and Olympic Commissary Storage Warehouse and offices.
4. Inter-area. - Gondola repair shops, radio transmitter station, dog pound, ice pit, sanitary disposal area, pistol and machine gun range, and mix plant for road materials.

5-9. Hanford Airport (See App. A 78). - A single lane, 30-foot wide, blacktop landing strip, approximately 2000 feet long, was

originally constructed at Hanford. This served as an emergency airport for the smaller type aircraft assigned to the Area Engineer for the Project. As the Hanford Camp expanded, this strip had to be abandoned as proper clearances could not be maintained. By this time the number of air-express shipments arriving at the plant daily warranted the construction of an airport of sufficient size to accommodate aircraft used by the Air Transport Command. Therefore, an airport was constructed approximately one mile west of Hanford, between the Hanford-White Bluffs road and the south end of Cable Mountain, in order to make direct delivery of air-express shipments to the plant site. The airport consisted of two landing strips, one running almost north and south, and the other east and west. Both strips were 200 feet wide, with the north-south strip approximately 4000 feet long and the east-west strip approximately 2400 feet long. Two hangars and a Pacific-type Hutment were erected east of the airstrip intersections. Electrically driven gasoline pumps, with underground storage tanks, were provided for the refueling of Army planes.

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SECTION 6 - CONSTRUCTION OF THE OPERATING PLANT

6-1. General. - Construction of the operating plant was begun in March 1943. Work progressed in all areas simultaneously, with construction proceeding more rapidly in some because of higher priority, resulting in diversion of an already deficient supply of manpower from the less critical areas. A shortage of labor existed throughout the construction period, with particular scarcities in workmen skilled in the special crafts required, such as pipe fitters, welders, carpenters, electricians, and millwrights. Schedules, despite the critical nature of labor and materials, were maintained in most cases by an efficient program of expediting. Construction operations were completed in March of 1945.

6-2. Metal Fabrication and Testing (500) Area (See App. A I7, A 79-84, B 55-56, S 56). - This area was constructed to provide facilities for testing the materials used in constructing the production Piles and for fabricating the metal to be charged into the Piles, as well as to provide laboratory facilities for process development and test work. It is composed of a total of 41 permanent buildings and 19 facilities (See App. B 55). Three general types of construction were used in this area; i.e., reinforced concrete, structural steel framing together with concrete blocks or reinforced concrete, and wood frame construction.

a. Preliminary Work. - Layout work for the Metal Fabrication and Testing Area started 6 April 1943, when the preliminary topographic survey was begun. The horizontal and vertical controls

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for this area are an extension of the coordinate system established for Richland Village (See App. A 18).

b. Progress of Construction. - Many of the buildings were to operate independently; therefore, sequence of start-ups was not interconnected. However, the Metal Fabrication (313) Building had to be in production for several weeks in order to provide the initial charge for the 105-B Pile Building start-up; similarly, for construction to start on this Pile Building, the Test Pile (305) Building had to be completed. Consequently, completion and start-up dates were set for each individual building in the area rather than for the area as a whole. Inspection of the over-all progress charts of the 300 Area (See App. B 36) will show that early progress in this area was slower than could be anticipated. This was due principally to the fact that design progressed as construction advanced.

c. Construction Difficulties. - During the construction of the Metal Fabrication and Testing Area, various difficulties were encountered. Since this area provided extensive laboratory facilities for the Hanford Engineer Works, these difficulties were somewhat different from those encountered in the other process areas.

(1) Design. - The greatest single difficulty was in the stabilization of design. This was due entirely to the fact that there existed very little previous experience or precedent in this type of construction from which to draw. As the needs became apparent, additions and changes were made. In addition, a large amount of experimental work was carried on, in buildings already erected in the area and at other points in the United States, from the fall of 1943

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through the summer of 1944 (See Vol. 2), resulting in numerous changes to buildings and equipment, such as building additions, equipment relocation or removal, and room rearrangement.

(2) Experimentation. - Throughout construction, a considerable amount of experimental work was carried on, particularly in connection with the Metal Fabrication (312) Building. This experimentation was responsible for a number of the building and equipment changes (See Vol. 6). As the processes were being changed, design and construction would be delayed; when a process was decided upon, the design was released and construction resumed. Construction work in the Metal Fabrication (312) and Press (314) Buildings was greatly affected by this experimental work. An experimental fabrication line was installed and changes were made to this equipment throughout the experimental period by the construction forces under the direction of

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the Operations Division.

(3) Labor. - The supply of labor to the Metal Fabrication and Testing Area was generally inadequate principally because, with the exception of three or four buildings, completion of other areas was more urgent. The area could not be sure of any prearranged allocation of labor but took available manpower from week to week (See App. B 25).

(4) Restricted Area. - Because of the fact that several buildings in this area were of a classified nature, work was somewhat hampered by the restrictive measures necessary (See Vol. 1). The first major process building in the area went into operation during March 1944, resulting in additional measures to segregate the

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construction and operating personnel.

(5) Construction Schedule. - Completion of the Semi-Works Separation (321) Building was somewhat hampered by the position it occupied in the over-all project schedule. This schedule called for completion of the two Separation Buildings, (221-T) and (221-U), in the West Separation Area, the Semi-Works Separation (321) Building, and the Separation Building in the East Separation Area, (221-S), in that order. Much of the material and equipment originally scheduled for the semi-works was allocated to the Separation (221-S) Building, since this building was the larger and more complex of the two. Practically all major equipment for the semi-works was procured on the same purchase order or from the same vendor furnishing the equipment for the Separation (221) Buildings.

d. Construction Expedients. - There was very little unusual construction involved in the Metal Fabrication and Testing Area, with the exception of the process equipment in the Test Pile (306) Building, which is similar to that used in the Pile (105) Buildings. Normal construction expedients and practices were used in the construction of this area.

(1) Labor. - The need for certain buildings within the area became critical, and labor was allocated in these cases. To make the most effective use of this labor, shift work was generally resorted to. Construction work on the Metal Fabrication (315) Building was placed on two nine-hour shifts from 1 May 1944 through July; work on the Press (314) Building was placed on two nine-hour shifts from 1 August 1944 until mid-September and again for

approximately two weeks during the latter part of December. Shift work might have speeded construction of the Semi-Works Separation (321) Building for certain periods, but the over-all equipment and material program was such that continuous shift work would not have affected the final completion date.

(2) Design. - The Operating Department prepared drawings, based on experimental conclusions, for issuance directly to construction forces (with the necessary approvals). This procedure greatly speeded up the work, particularly for the Metal Fabrication (313) Building. Under the usual procedure, the Operating Department would make its needs known to the Design Division in Wilmington, which, in turn, would prepare the drawings for issuance to the field.

(3) Material Procurement. - Many orders for material and equipment for Metal Fabrication and Testing Area buildings were placed at a late date because of delayed design. A number of orders were given special handling so that material or equipment would arrive in sufficient time to prevent construction delay. Railway and Air Express were used for special orders.

(4) Subcontracts. - A portion of the labor employed and equipment used in the construction of this area was obtained by subcontracts. The primary reason for employing the subcontractors was the specialized nature of the work involved. The subcontractors had available the qualified personnel and the necessary equipment (See App. B 37).

6-3. Pile (100) Areas (See App. A 19-21, 85-93, 94-104). - Included in the construction of the Hanford Engineer Works were three

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separate but similar areas known as the Pile Areas (designated 100-B, 100-D, and 100-F). These areas are composed of a total of 35, 34, and 32 permanent buildings and 32, 29, and 28 facilities respectively (See App. B 38). Three general types of permanent building construction were used, i.e., reinforced concrete, structural steel frame together with concrete block or reinforced concrete, and wood frame (See App. B 56).

a. General Pile Area Construction.

(1) Preliminary Work. - Layout work in the Pile Areas was inaugurated on 19 March 1945, at which time field work for preliminary topographic surveys was begun. This work was completed in the B-Pile Area on 15 April 1945, in the D-Pile Area on 28 May 1945, and in the F-Pile Area on 8 June 1945. During the last two weeks of October 1945, the fence line for the B-Pile Area, which included part of the temporary fence and part of the permanent fence, was staked out. Layout for site clearing and excavating for the first permanent process building, the Retention Basin (107-B), was made on 29 July 1945, and similar layout for the last permanent process building, Fresh Metal Storage (108-F) Building, was laid out on 16 October 1944.

(2) Progress of Construction (See App. A 94-97).

(a) Requests for Completion. - The chart showing the sequence of start-ups as requested by the Prime Contractor's Operating Department (See App. B 39) shows a requested completion date for the Pile (105-B) Building of 15 August 1944. The Pile (105-D) Building was requested for 15 October 1944 and the Pile

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(105-F) Building for 18 February 1945. Inasmuch as the Pile Building was the controlling factor in the start-up and completion of each of the Pile Areas, these dates applied to the areas as a whole. The Operating Department's scheduled start-up dates coincided with these construction completion dates.

(b) Rate of Completion. - Although the B-Pile Area was not completed until September 1944, the D- and F-Pile Areas followed in their scheduled order (See App. B 40). Construction of the B-Pile Area proceeded slowly during the first four months, progressing less than 15 per cent, but from that point on the construction proceeded at a much faster rate. During August, the construction progress in the D- and F-Pile Areas was slow, but was more rapid during September. Progress was retarded in October because of the borrowing of workers for the West Separation Area (See Par. 6-4).

(3) Pile Area Construction Difficulties. - Prior to and during construction of the Pile Areas, numerous difficulties were encountered. These difficulties were, for the most part, caused by wartime conditions, but the location of the Project and the type of plant to be constructed were also important contributing factors.

(a) Labor. - The scarcity of labor was more marked in the B-Pile Area than in the D- or F-Pile Areas because the former was the first constructed and its manpower requirements had to be filled during one of the most critical periods of the Project recruitment program (See Par. 4-2). The most critical labor shortage in the D-Pile Area was in the pipe fitters craft, from 1 July 1944 through 1 September 1944 (See App. B 9). The construction

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schedule for the F-Pile Area was such that it was able to draw on manpower released from the B- and D-Pile Areas.

(b) Material. - Critical items of material causing delay in the Pile Areas were solenoid valves, self-cleaning strainers, and synthetic cable. Additional critical material items, causing delay in the D-Pile Area, the only area equipped with a demineralization unit, were stainless steel fittings and valves, as well as various items of the Permutit equipment in the Demineralization Building. With a few minor exceptions, persistent expediting and special handling of particular orders resulted in materials and equipment arriving on the Project in sufficient time as to not to delay the final completion of the areas.

(c) Design Changes. - As there had been no experience in the construction and operation of a plant similar to

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the Hanford Engineer Works, it was natural that many design changes would occur. The need for some of these changes was not apparent until the start-up of the B-Pile Area. Many of the design changes in the Pile Areas were made as construction expedients rather than as changes in the process. The greater portion of these changes occurred in the B-Pile Area since this was the first of the three Pile Areas constructed. The major design changes encountered were in the piping layout. These, combined with the shortage of pipe fitters, required considerable overtime work to maintain the schedule.

(4) Pile Area Construction Expedients. - In overcoming the difficulties encountered in the construction of the Pile Areas, every attempt was made to employ expedients wherever possible.

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It is not possible to evaluate those expedients in terms of time gained or manpower saved, but they were used wherever it was felt they would assist in speeding up the construction program or would result in a saving in manpower or materials, or both.

(a) Working Hours. - In order to utilize fully the supply of labor available for the Pile Areas, shift work, extended work periods, and Sunday work were resorted to. Originally, the work week at the Hanford Engineer Works consisted of six eight-hour days. On 14 September 1943, however, this was changed to six nine-hour days for manual and non-manual employees alike. In addition, many of the employees, particularly manual, worked ten hours or more a day seven days a week for periods as long as three or four months.

(b) Subcontracts. - A portion of the labor and the materials employed in the construction of the Pile Areas was obtained under subcontract. It was found expedient to award 38 individual subcontracts for work in these areas to 25 contractors who had available qualified personnel and the necessary equipment (See App. B 41).

(c) Procurement. - The problem of procurement was minimized through persistent expediting and advance planning. Steel plate, steel pipe, and fabricated steel vessels were procured. For example, rather than ordering from one or more vendors, the Prime Contractor in many cases purchased raw materials to be used by the fabricators. In some cases, because of a lack of adequate facilities, one vendor would perform only a portion of the fabrication,

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other venders would perform additional fabrication, and still others would assemble the fabricated parts. In one instance (steel plate), raw stock was delivered to a subcontractor who warehoused, cut, and issued the steel to other contractors for fabrication of the finished articles and shipment to the Project. It should be noted that most of the raw material orders for critical items were placed prior to the completion of design in order that no delays would be encountered when the drawings were issued (See Sec. 5).

(d) Design Representation in the Field. - Early in 1944, a group of representatives of the Prime Contractor's Design Division came to the Project. Those connected with the Pile Areas were located in the Division Engineer's office in the B-Pile Area. These representatives were specialists in various lines of work, authorized to make minor design changes in the field without consulting the Wilmington office. This procedure greatly expedited work in the areas since problems arising in the field concerning design were handled promptly.

(5) Construction Methods. - In general, the construction methods used in the Pile Areas were not unusual. However, the construction of the River Pump House (181) Building river intake channels and foundations are of special note.

(a) Foundations (See App. A 98). - In the construction of the foundation for the River Pump House (181-B) Building, an earth-fill coffer-dam was placed on the river side of the foundation excavation. A sheet pile enclosure was placed around the excavated area to take care of ground water and river water seepage.

This seepage was found to be so low that it could be handled adequately with batteries of temporary pumps. Consequently, a sheet pile enclosure was not used for the River Pump House (181-D and 181-F) Buildings.

(b) Intake Channels. - To construct the water intake channel for the River Pump House (181-B) Building, an earth-fill causeway for supporting the excavation equipment was built in the river to the far end of the proposed channel. When the concrete foundations and channel excavation had been completed, the dike was removed. The excavation scheme employed on the D-Pile Area channel was similar, differing principally in types of equipment and temporary supports. Instead of building an earth-fill causeway the entire length of the proposed channel, a wooden pier beginning at the bank was erected for approximately two-thirds of the distance to support two large electrically driven dragline excavators. The pier was removed after the channel excavation had been completed. The construction of the F-Pile Area channel, which was much shorter than the other two, was handled similarly to that in the B-Pile Area.

b. Pile Building Construction (See App. A 98-102). - Because of the highly specialized and complex type of construction involved in the Pile Buildings and the need for the maintenance of the utmost secrecy, these buildings were constructed under the supervision of a separate organization headed by a Division Engineer. This group also handled the construction of the process equipment in the Test Pile Building (See Par. 6-2), as well as the stack portion of the Pile Buildings.

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(1) Preliminary Work. - Layout work for the Pile (105-B) Building was started on 9 October 1943, when reference points on the center lines of the process unit were established. This building was staked out for excavation on 10 October 1943, the Pile (105-D) Building on 6 December 1943, and the Pile (105-F) Building on 15 February 1944. Prior to the setting of foundation forms, seven test tables (See App. C 23) were set for the Pile (105-B) Building, five for the Pile (105-D) Building, and seven for the Pile (105-F) Building. Of these nineteen tests, three failures resulted for the Pile (105-B) Building and two for the Pile (105-F) Building. In each case, the failure was the result of a local condition which was remedied by deepening the excavation of these points and back-filling with lean concrete.

(2) Permanent Area Work. - All of the outside facilities to and from the Pile Buildings, i.e., underground pipe and pipe tunnels, overhead pipe, outside electric lines, and transformer banks, were constructed under the direction of the Division Engineers for the respective Pile Areas rather than that of the Division Engineers for the Pile Buildings. When the work within each of the temporary enclosures had reached a sufficiently complete stage of construction, a permanent fence was erected within each Pile Area and the temporary fence was dismantled. This permanent fence surrounded the Fresh Metal Storage (103), Pile (105), and Helium Purification (115) Buildings, the Helium Storage Tanks, the Elevated Water Storage Tanks, and the Ventilation Exhaust Stack in each Pile Area.

(3) Process Unit Construction. - In the construction

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of the process units for the Pile Buildings, somewhat different methods and techniques were required than in the ordinary type of industrial construction.

(a) Pile Erection. - The Pile (See App. A 28) is a cube-like structure approximately 41 feet high by 46 feet wide by 38 feet deep. It consists of an interior mass of graphite approximately 36 feet high by 38 feet wide by 28 feet deep surrounded on the top and sides by laminated walls of steel and masonite, the entire structure being supported on concrete approximately 28 feet thick. Between the graphite and the concrete foundation, and between the graphite and the laminated walls on the top and sides of the Pile, is a thermal shield of cast-iron blocks; this shield is approximately 10 inches thick on the top, front, back, and bottom of the Pile and 8 inches thick on the sides of the Pile. Each Pile contains 2004 holes for the aluminum cooling-tubes which extend from the front or charge face to the rear or discharge face of the Pile. Twenty-nine vertical holes are provided in the graphite for the safety rods, as well as nine holes, running from the left or control side to the right side, for the horizontal control rods (See App. A 30, 31). Through the cast-iron thermal shield from the front to the rear of the Piles are 208 holes for cooling water pipes. On the charge face of the Pile, an elevator supports a machine for inserting or placing charges in each of the aluminum tubes through a stainless steel extension or "nozzle." An elevator on the discharge face contains a cab or enclosed mechanism for mechanically meeting emergencies in the operation of the discharge face of the Pile. A nozzle, attached to the front and rear end of

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each aluminum tube and containing a removable bayonet lock cap, diverts process water into the aluminum tubes from headers running along the face of the Pile (See App. A 32). In the construction of the Pile base, three separate placements of concrete were made. The first was the rough or foundation placement, while the second enclosed the main gas inlet and outlet lines, with the third enclosing the gas headers and instrument ducts. Between the second and third placements, a steel membrane, or lining, was fitted which was later welded to the laminated steel walls in order to make the entire Pile gastight. The third placement was the one in which the cast-iron base was grouted (See App. A 33). When a portion of the four side walls of the Pile had been completed, the installation of the cast-iron base was begun. The interior portions of the side walls were then completed and the erection of the graphite interior was started (See App. A 103). While the graphite was being placed, particular emphasis was placed on keeping this portion of the Pile free from dirt or any other contamination. All men working on the graphite were required to wear special uniforms. As each graphite layer was laid, it was thoroughly vacuum cleaned to insure that no dirt remained between the blocks. While the graphite blocks were being laid, the cast-iron thermal shields were placed, as were the instrument thermocouples. When the graphite structure was completed, the top layers of cast-iron blocks and masonite and steel laminations were placed on the Pile and the installation of the vertical rods was started.

(b) Graphite Fabrication. - The center portion of the Pile consists of a number of layers of graphite blocks, some of

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which are solid, some have longitudinal holes drilled in them, some have key-way slots of various kinds, and some have beveled edges. These blocks vary in length from 20 to 40 inches and have a 4-3/16 inch square cross section. Based upon the experience gained in the erection of the Clinton Laboratories Pile (See Vol. 2), it was decided that the rough graphite would be machined at the site. Consequently, special fabrication shops were constructed for this purpose (See Sec. 8). The rough graphite blocks, as received from the vendor, were plainly marked with the heat and quality numbers and could be identified by these and additional numbers until installed in the Piles. Machining of the first 315 tons of graphite, all of which went to the Test Pile (306) Building, was done on machines temporarily equipped for the job. In order that machining operations might get under way on schedule, such equipment as was available (or could be procured in time to meet the scheduled dates) was placed in service. This original method proved to be entirely too slow, however, and additional machines were procured so that the graphite could be machined on an assembly line basis. Practically all of the equipment used in machining the graphite was converted woodworking machinery, and each machine was set so that its operation would not require individual settings of the blocks. The development of the equipment used in the machining of the graphite was accomplished, almost entirely, on the Project site.

(e) Front and Rear Laminations (See App. A 30, 31). - The front and rear faces of the Piles consist, respectively, of 121 and 132 prefabricated laminated blocks of masonite and steel ("B" blocks) each approximately a four-foot cube weighing ten tons. These

blocks were received at the Project already fabricated. Diagrams, received with each carload, gave exact measurements of each block and were used to determine what position each block would occupy in the Pile. This was necessary in order that the cumulative dimensional variations would not exceed the allowable tolerances. After receipt of the blocks on the Project, it was necessary only to clean them, using carbon tetrachloride, and buff them.

(d) Side and Top Laminations (See App. A 33). - The sides and the tops of the Piles consist of a series of steel and masonite laminations approximately four feet thick. The work of fabricating and installing these laminations was done entirely on the Project site (See Par. 5-4). The steel was received in sheets approximately 1-7/8 inches thick and the masonite in sheets approximately 1/8 inch thick. The masonite was pressed and fastened into blocks of 36 layers and was then drilled and sawed for its location in the Pile. The steel plates were machined and punched. Assembly of the steel and masonite laminations took place at the Pile. Each wall contains a total of 28 inches of steel and 24 inches of masonite.

(4) Pile Building Construction Difficulties. - During the construction of the Pile Buildings, a variety of difficulties was encountered because of the size and complexity of the buildings and the uniqueness of some of the materials used.

(a) Labor. - The greatest difficulty encountered in the construction of the Pile Buildings was the procurement of an adequate supply of qualified labor (See App. B 9). This difficulty was heightened by the fact that the average worker in the various

crafts was not sufficiently skilled for work on the fabrication, or assembly, of materials in the process units. In addition, since all work connected with the Pile was of a "classified" nature, every worker had to be "cleared" before being permitted to work on the Pile (105) and Test Pile (305) Buildings or on the fabrication of materials for these buildings (See Vol. 1).

(b) Material Procurement. - There were many problems arising from the procurement of materials for the Pile (105) and Test Pile (305) Buildings because of the unusual materials used and the amount of field fabrication work necessary. The Pile (105-B) Building, the only one actually delayed because of material difficulties, was completed three weeks late because of late delivery of material handling equipment.

(c) Massive Construction. - One of the most important factors tending to impede the construction of the Pile Buildings was the quantity of materials installed in the Pile (See App. B 42). These materials were erected in a space approximately 46 feet wide by 40 feet deep and 41 feet high. Approximately 1200 different drawings, not including the additional drawings resulting from revisions, were required for these buildings.

(d) Close Tolerance. - Very close tolerances were required in the construction of the Piles. The cast-iron base for the Piles had to be machined within 0.005 inch, and had a flatness tolerance after grouting in the concrete of plus or minus 0.005 inch. The steel and masonite laminations on the sides and top of the Pile had to fit against the steel webs ("T" sections) with a gap of less than

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0.005 inch at any one point. The setting of the gun barrels (steel sleeves which carry the aluminum tubes through the Pile shielding), "bellows,"* and various other metal fittings on the charge and discharge faces of the Piles (See App. A 32), was to 1/64 inch. The graphite blocks were laid with a tolerance of plus or minus 0.005 inch from the center line. The setting of the "B" blocks was at a tolerance varying from plus or minus 0.005 inch for the blocks at the bottom of the Pile to plus or minus 0.015 inch for the blocks near the top of the Pile. In making the "Van Stone flanges"* on the aluminum tubes (See App. C 24), a tolerance of plus 0.001 inch in the thickness of the tube side-wall was permitted. These tolerances, together with the massive size of the structure and the unusual materials used, made the construction of the Piles a difficult and slow process. It was not simply a case of close measurement, but of developing new techniques and methods of handling the materials.

(e) Tests. - Numerous and varied tests were necessary to insure that the erection of the Piles was proceeding as specified. Random samples of the graphite blocks were checked for purity and quality in the Test Pile (305) Building. There were, in addition, a number of tests on the other materials and on the Pile itself during construction. All aluminum tubes were given a 350-pound hydrostatic test, as well as a thorough visual examination of the exterior of the tubes. All bellows were pressure-tested under water. The gun barrels were checked for size to insure proper clearance for the aluminum tubes. All "donuts" (steel rings surrounding the gun barrels to allow for lateral motion of the gun barrels and aluminum tubes) were

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set on mandrels and checked for eccentricity and size, and the cast-iron base of the Pile was checked for high spots.

(f) Construction Techniques. - Because of the unusual materials used in the Piles, new techniques had to be developed and old techniques revised to meet the new conditions. In the machining of the graphite blocks, for example, there was little previous experience or precedent from which to draw, with the exception of the work done at the Clinton Laboratories (See Vol. 2). It was only natural, therefore, that a certain amount of experimental work would be required in order to develop suitable techniques. Similarly, methods had to be devised for handling the masonite used in the side walls and the top of the Piles. New techniques had to be developed, for handling, cutting, and punching (or drilling) holes in the masonite, because of quantity, close tolerances required, and the hardness of the masonite.

(5) Pile Building Construction Expedients. - In the construction of the Pile Buildings, every attempt was made to employ expedients wherever possible. In addition to those expedients applicable only to the construction of the Piles, most of the general expedients used in the Pile Areas also apply to the Pile Buildings.

(a) Labor. - Because of the very limited working space in the Pile Buildings, it was not possible to speed up the work simply by increasing the labor force. The only way an augmented labor supply could be used to advantage was through shift work.

(b) Subcontracts. - It was found expedient to award nine subcontracts to nine different vendors for work on these buildings (See App. B 41). With the exception of the two fixed-fee

subcontractors, only one of these subcontracts was for work in connection with the process units. This subcontract was awarded to the Haughton Elevator Company for the installation of elevators on the front and rear faces of each of the three production Piles. In addition to these "formal" subcontracts, requiring labor on the plant site, a number of purchase orders involving erection supervision were issued (See App. B 41).

(c) Material Procurement. - The problems of procurement for the Pile Buildings were kept to a minimum through persistent expediting and advance planning (See Sec. 3). There were, however, critical points throughout the construction period when the procurement problem threatened to, or actually did, delay completion of the buildings. Because of the isolation of the Hanford Engineer Works' site and the lengthy shipping distances from vendors, air express, rail express, and truck shipments were used whenever necessary to insure early delivery. Many other items, particularly for the Pile (105-B) Building, were given special handling and were flown direct to the Project by the Air Transport Command of the Army Air Forces. One item which was shipped in an unusual manner was the Pile discharge face elevator cab for the Pile (105-B) Building. Since the experimentation and test work required on this cab greatly delayed its shipment to the Project, the cab was shipped by railway express, necessitating that the wheels, couplings, and hose connections of a freight car be converted so that it could be hauled in a passenger train.

(d) Construction Methods. - Inasmuch as the process requirements for the Pile Buildings necessitated keeping the process

units (and adjoining equipment) as free from dirt and contamination as possible, a slight positive air pressure was maintained in the buildings, using filtered air. To accomplish this, temporary air blowers were used, until the permanent ventilation system had reached a sufficiently complete stage to be put into operation. A temporary "air-lock" (See App. A 106), having a concrete floor and occupying approximately 10,000 square feet, was erected on each Pile Building. All materials for the process units were brought in through the air-locks and, if necessary, stored there temporarily. Minor fabrication work, such as cleaning and buffing, was also performed in the air-locks. To bring the materials from the air-lock to the process unit in the Pile (105-B) Building, tracks were laid, on which small hand cars operated. This track system was not used in the Pile (105-D and 105-F) Buildings. Instead, a steel and concrete roadway was laid into the process unit, over which a small electrically driven truck towed small cars carrying materials. Erected above each Pile was a 15-ton traveling crane which was used throughout the construction period and then was dismantled. Above the work area, in front of the Pile, were a number of air and electrically operated hoists which were also dismantled at the completion of construction. Since the cranes and hoists used in the Pile (105-B) Building were dismantled in sufficient time to be used in the Pile (105-F) Building, only two sets of cranes and hoists were necessary. In order to start Pile erection in the Pile (105-B) Building as soon as possible, despite the fact that the building itself had not been completed, a temporary cover or section was placed over the Pile. A cover was not necessary in the

Pile (105-D and 105-F) Buildings since the building structure had progressed far enough by the time erection was started.

6-4. Separation (200) Areas (See App. A 22-24, A 105-124). - The construction of three Separation Areas (West, East, and North), was included in the scope of work covered by Prime Contract W-7412 eng-1 (See App. C 1) for the construction of the Hanford Engineer Works. The East and West Separation Areas are process-finishing areas containing the same process buildings, service buildings, and facilities, with the exception of a few minor changes in each area. The West Separation Area contains two identical process plants (200-T and 200-U) while the East Separation Area contains one process plant (200-B). The North Separation Area is used for lag storage between the Pile and the East and West Separation Areas. The East, West, and North Separation Areas are composed of a total of 14, 21, and 5 permanent buildings and 44, 62, and 14 service facilities, respectively (See App. B 48). Five general types of permanent building construction were used for these areas: reinforced mass concrete construction, structural steel frame and concrete block construction, reinforced concrete frame and concrete block construction, structural steel frame and wood construction, and wood frame construction (See App. B 56).

a. Preliminary Work. - Layout of the Separation Areas was begun on 27 March 1943, at which time horizontal and vertical controls were established in order to prepare a topographic map of the areas. These maps were required as a basis for the location of permanent buildings and facilities. From time to time, additional inter-area topography was requested for locating facilities, and outlying

portions of these areas not included in the original survey, were mapped.

b. Progress of Construction (See App. A 111-124).

(1) Schedules. - At the inception of the formal contract, completion and start-up dates other than the "earliest possible" date were not established for the Project, or any portion of it, at that time, since it was impossible to ascertain or to estimate these dates accurately. There were too many indeterminate factors such as availability of manpower, uncertain delivery dates for special equipment and critical material, and length of time required for experimental design. However, despite these unknown factors, completion forecast schedules for the West, East, and North Separation Areas were drawn up on 30 September 1943 (See App. B 24). The original forecasts were based upon a combination of the preliminary design schedule, meager procurement information, and an estimate of time required for building construction and equipment installation, predicated on the fact that only 18 per cent of the total drawings had been issued for the Separation Areas. These over-all schedules were revised on 15 March 1944, and that for the East Separation Area again on 23 August 1944, with revisions based primarily on available force and the intention of bringing the design and procurement schedules into line. Shortly after construction was begun, a desired sequence of process area start-ups was decided upon, which gave the time lag for each succeeding area after the initial area start-up (See App. B 39). These indicated the length of time that certain buildings would be required in each area prior to start-up. In the construction of the

Separation Areas, start-up dates for each process plant were set to coincide with the completion of construction, since operation of such plants while construction was still in progress could not be permitted due to the plant security necessary to cover methods of manufacturing. Using this information, together with the previous area forecast and bar charts, on 10 February 1944 a "Preliminary Sequence of Start-up Chart" (See App. B 39) was prepared for the Pile and Separation Areas, which was used thereafter as the basis for all building and area construction schedules. This chart was revised several times, since it was contingent upon the availability of labor and the receipt of critical materials. On 8 August 1944, because of changes in production requirements at Hanford, new emphasis was placed on the early completion of the D-Pile Area at the expense of one plant (200-U) in the West Separation Area.

(2) Rate of Construction. - Permanent construction work did not progress as rapidly as desired for a period of four to six months after ground had been broken, as only a limited amount of manpower was available. The work performed during that time consisted mainly of mass excavation work for permanent buildings and temporary construction work to provide areas with necessary construction facilities. After this period, however, progress improved sufficiently, so that the over-all schedule for the Separation Areas was met (See App. B 44).

(a) West Separation Area. - Work was officially started in this area on 26 June 1943, but, at the end of December 1943, the area was only three per cent complete. From that time on,

a sharp increase in the rate of construction was noted and continued with an increasing rate to the end of July 1944. Approximately 15 per cent of the physical work was accomplished during the month of July 1944. At this point the rate of construction began to diminish, but failed to follow a smooth curve because of the fluctuation in the labor supply for this area. This area was completed in December 1944.

(b) East Separation Area. - Ground was officially broken in the East Separation Area on 2 August 1943. Early construction work in this area was hampered by a shortage of labor, so that, at the end of April 1944, the area as a whole was only six per cent complete. From this time on, the tempo of construction increased and continued with an increasing rate through August 1944. During August alone, 18 per cent of the total physical work was accomplished. For the next four months, the rate of construction diminished, with an occasional increase for a short period of time because of the fluctuation in manpower available for allocation to this area. The area was completed in February 1945.

(c) North Separation Area. - Ground was officially broken in the North Separation Area on 17 November 1943, but progress was limited until sufficient manpower could be obtained. This shortage was overcome during the latter part of March 1944, and a sharp increase was noted in the rate of construction for this area. During June 1944, 28 per cent of the physical work was accomplished. From that time on, the rate of construction diminished in a smooth curve. The area was completed in November 1944.

c. Separation Area Construction Difficulties. - In the

construction of the Separation Areas, a number of delaying factors were encountered because of the Project location, nature of the work, type of construction, and wartime conditions.

(1) Labor. - The shortage of labor, both skilled and unskilled, was the greatest difficulty encountered in the construction of the Separation Areas. Shortages in common labor prevailed throughout the entire construction period, while the scarcities in the skilled crafts were intermittent. From time to time, scarcities were encountered in nearly all crafts (See App. B 9). Because the Prime Contractor was unable to secure sufficient workers to man all the areas simultaneously, allocation of labor became necessary in order to perform area work in sequence of area start-ups. Critical craftsmen were shifted continually from one area to another to meet start-up dates. Absenteeism and the high rate of labor turnover were additional factors contributing to delay early in the construction period.

(2) Material. - The principal material problem in the completion of the Separation (221-T) Building was the late delivery of stainless steel through-concrete cell piping. This condition was improved for the Separation (221-U and 221-B) Buildings by changing the vendor's shop fabrication sequence schedules to meet field requirements. Late deliveries of cell piping, cell equipment, and the 10-ton crane for the head-end addition to the Separation (221-T) Building delayed the final completion of this building by approximately two weeks. Cast-iron cell and trench forms were received approximately two weeks too late to allow 100 per cent use in the Separation (221-T) Building, thereby requiring the construction of some wooden forms to

prevent further loss of time. Approximately two months' delay was encountered in the installation of cell and gallery equipment in the Concentration (224-T) Building because of the difficulties in obtaining stainless steel tanks and piping for this building.

(3) Design Changes. - During the course of construction, revisions were made to the original drawings, some in the form of additions and changes, others covering deletions. Some of these required major changes or came late in the job, causing the construction schedule for one of the process groups (200-T) in the West Separation Area to be extended.

d. Separation Area Construction Expedients. - Whenever and wherever feasible, expedients were employed to alleviate or to overcome the difficulties encountered in the construction of the Separation Areas. These expedients were effective in maintaining over-all schedules and in preparing the plant for production at an earlier date than was expected.

(1) Working Hours. - Because of the lack of adequate manpower, close construction sequence for some process buildings, and late deliveries of materials, shift work, Sunday work, and extended working hours were employed in order to meet the completion schedules set for the East and West Separation Areas (See App. B 45).

(2) Subcontracts. - A total of 28 subcontracts were awarded to 23 separate subcontractors (See App. B 46) for certain phases of construction work in the Separation Areas. These awards were made for the following reasons: to speed up construction, to obtain specialized labor and supervision, to eliminate delays in the

procurement of special construction equipment, to make use of extensive organization and personnel of specialized contractors, and to complete each phase of work in the shortest possible time.

(3) Premium Payments. - A number of premium payments were awarded vendors in order to expedite the delivery of critical materials and equipment under fabrication in their shops (See App. B 47). The largest and most important, amounting to approximately $100,000, was made jointly to Waldrip Engineering Company, Hollidate, California, and the Associated Piping Engineering Company, Los Angeles, California, vendors for the fabrication of cell and through-concrete piping. This premium was allowed these companies for Sunday and overtime work and for changing their shop fabrication sequence to meet field requirements.

(4) Procurement. - One of the major factors contributing to the scheduled completion of the process plants was the early placing of blanket orders for 25-12 Cb and 18-8 stainless steel plate, tubing, and bars with G. O. Carlson Company, Allegheny-Ludlum Steel Company, and the Carpenter Steel Company. Up to that time only a small amount of 25-12 Cb special stainless alloy had been rolled, and none was available on the open market for immediate purchase. These orders were placed several months prior to the release of design for process equipment. Knowing that vendors normally wait until drawings have been received and material lists have been made before placing orders for material required for fabrication, the Prime Contractor procured the necessary stainless steel stocks for the vendors in order to expedite fabrication. This material was used in the fabrication of

centrifuges, precipitators, condensers, agitators, tanks, piping, siphons, valves, and miscellaneous assemblies. Approximately 700,000 feet of stainless steel piping, from 1/4 inch to 3-1/2 inch in nominal diameter, and 150,000 stainless steel bolts and nuts were required for the Separation Areas. At least three to four months' time was gained in delivery of this material.

(5) Air and Express Shipments. - Air, express, and truck shipments were used for the more urgently required materials. Express and truck shipments were made from vendors east of the Mississippi River to the nearest Air Transport Command for consignment to the Hanford Engineer Works. During the latter part of construction, the Army Transport Command delivered air shipments directly to the Project, using the Hanford Airport.

(6) Design Representation in the Field. - A representative of the Prime Contractor's Wilmington Design Division was present in the field during the major part of the construction period to serve as an immediate contact between the Construction and the Design Divisions, and to act as a consultant in handling local design problems. This aid was invaluable at the start of construction, because the field forces were unfamiliar with this new type of design, and because a sufficient number of drawings had not then been issued to indicate the full scope of the work. This service was especially beneficial in planning construction, and in working out the last-minute design details for minor changes normally found necessary prior to, and at the time of, start-up.

e. Special Construction Methods. - It was recognized that

special construction methods and sequences of operation would have to be adopted and followed in the construction of the Separation (221) Buildings in order for precision workmanship and speed to be attained. Many conferences of field and design engineers resulted in the preparation of a complete concrete placement schedule, production line preassembly of cell equipment, specifying of certain field fabrication, and design of special tools and equipment for the expeditious handling of this work. The field forces from time to time added to the above methods, taking advantage of latest devised construction methods, tools, and equipment.

(1) Pre-assemblies. - The method of installation of process equipment in the Separation (221) Buildings' cells (See Vol. 8) differed from any normal job in several respects. Each cell contained from one to three pieces of equipment and 25 to 35 piping assemblies. The equipment and piping were assembled into units in the Area Shop (272) Building and were then placed in racks and crates on flat cars and moved into the Separation Building for placement in the process cells by cranes.

(2) Field Fabrication. - Considerable time and labor was saved by fabricating certain equipment and materials in the field. Some of the most important items handled in this manner were special concrete forms, cell and trench cover blocks, centrifuge bases, crane cabs, reinforcing steel, and stainless steel pipe.

(3) Sequences. - Prior to the placing of concrete, a definite forming and concrete placing schedule was prepared for the Separation (221) Buildings to eliminate congestion of crafts and to

make use of standard forms. Drawings, issued to designate both horizontal section and elevation placements, simplified the construction of the buildings. Other detailed construction schedules for main process buildings were made and equipment installation procedures were prepared for similar assemblies.

SECTION 7 - CONSTRUCTION OF SERVICE FACILITIES

7-1. General. - Included in the construction of the Hanford Engineer Works were a number of facilities, such as the electric power system, the communication system, and the network of roads and railroads, which were to serve the Project as a whole rather than one specific area. Although existing facilities were revamped and used whenever possible, considerable new construction work was necessary in order to provide an adequate system of service facilities for the operating plant.

7-2. Power Transmission and Distribution. - Operating power used and transmitted at the Hanford Engineer Works was purchased from the Bonneville Power Administration as per agreement executed on 28 February 1944, by the Bonneville Power Administration and the United States Government (See App. G 28). Electric power required for the operation of the Pile and Separation Areas is supplied from the 230-kilovolt system of the Bonneville Power Administration through their Midway Substation (See App. A 126) which has for its immediate feeders, Grand Coulee and Bonneville Hydroelectric Plants. Power for the Metal Fabrication and Testing Area, the Administration Area, and Richland Village is obtained from the 115-kilovolt Midway-Walla Walla tie-line of the Bonneville Power Administration, from which delivery is made to the Project through the Pacific Power and Light Company's substation at Pasco and former substation at Hanford (this station was acquired by the Government). At these substations, the voltage is reduced to 66 kilovolts before final delivery to the areas over existing transmission

lines of the Pacific Power and Light Company. An additional 15,000 kilovolt-ampere 115- to 66-kilovolt transformer bank was installed by the Pacific Power & Light Company at their Pasco substation, in order to take care of the increased power load caused by the construction of additional housing in Richland Village. This bank was energized on 28 September 1944.

a. Operation and Maintenance. - On 25 February 1944, the du Pont Company assumed full responsibility for the operation and maintenance of all substations, transmission lines, distributing lines, and other property and facilities of the Pacific Power and Light Company on the Project site, which at that time had been acquired by the United States Government. The supplying of power loads for the Project was also taken over at this time by the Bonneville Power Administration.

b. Electric Lines (See App. A 25, 126-129). - The permanent power distribution system for the Project is composed of five transmission lines of different voltages containing separate closed loops, with a number of interconnections in the 115-kilovolt and the 66-kilovolt circuits for flexibility. The primary substations for the Pile and Separation Areas are fed by a 230-kilovolt line and associated loops, while the primary substations for the Metal Fabrication and Testing Area, the Administration Area, and Richland Village are supplied by 115-kilovolt and 66-kilovolt transmission lines. Power is transmitted by a 13.8-kilovolt line from a primary substation to the secondary substations in the East, West and North Separation Areas. A 2.3-kilovolt line distributes power to the widely separated portions of the North Separation Area.

(1) 230-Kilovolt Lines. - Profiles for the lines were started by layout on 15 August 1943 and completed on 4 November 1943. Construction of the main 230-kilovolt circuit followed on 23 November 1943, starting near the Midway Substation and working eastward. Work on the main loop was essentially complete by 1 July 1944. All of the 230-kilovolt transmission lines constructed are of the two pole, three wire, suspension bell-insulator type, using 636 MCM aluminum stranded wire and 70- to 85-foot wood poles with a 50-foot cross arm, allowing 24-foot minimum clearance between cables. Pole depths ranged from 8 feet to 17 feet with an average depth of 11 feet. Some of the holes, in the vicinity of the Midway Substation, were blasted out of solid rock. All other holes had to be dug with backhoes and draglines. Rotary hole diggers could not be used because of the depth of the holes and the nature of the soil. This condition was largely responsible for increased cost of construction.

(2) 115-Kilovolt Lines. - No portion of the 115-kilovolt line owned by the Bonneville Power Administration was acquired by the Government. The Metal Fabrication and Testing Area, the Administration Area, and Richland Village, in the southern portion of the Project, are supplied through 66-kilovolt lines from Hanford and Pasco substations tied to this 115-kilovolt line. That portion of the Pacific Power and Light Company's 115-kilovolt transmission line between the Hanford substation and the northern boundary of the Project site, approximately 8.8 miles, as well as the substation, was acquired by the United States Government. The Hanford substation contains two primary 115- to 66-kilovolt transformer banks, totaling 18,000

kilovolt-amperes; one secondary 66- to 6.9-kilovolt transformer bank, having a total capacity of 60 kilovolt-amperes; and a two-story reinforced concrete and concrete block switch house. The latter transformer bank is housed in the switch house, and formerly served the town of Hanford, Washington. Upon acquisition of the entire substation by the Government, the Prime Contractor negotiated a contract with the Pacific Power and Light Company for its operation and maintenance. On 20 February 1945, the responsibility for operation and maintenance of the substation passed to operations forces.

(3) 66-Kilovolt Lines. - That portion of the Pacific Power and Light Company's 66-kilovolt Yakima-Hanford-Pasco transmission line within the plant site, approximately 55.6 miles, was acquired by the United States Government and formed the greater portion of the permanent 66-kilovolt distribution system. The acquisition also included the Allard and White Bluffs substations. Circuit breakers were installed by the Pacific Power and Light Company on the southeast end of the line near the Columbia River crossing, on the southwest end of the line in the vicinity of Cold Creek, and on the 66-kilovolt transmission line of the Priest Rapids Irrigation District east of the new 66-kilovolt by-pass line of the Pacific Power and Light Company. This by-pass line runs from the Priest Rapids Generating Station, tying to the old 66-kilovolt Hanford-Yakima line outside of the west Project boundary. Only that portion of the reconditioned 66-kilovolt line between Hanford and Pasco was used for permanent power distribution. The 66-kilovolt transmission lines of the Pacific Power and Light Company and the Priest Rapids Irrigation District were of single pole, pin

insulator, triangle configuration construction. These lines were old but in fair condition, although approximately 15 per cent of the poles had failed at ground level and had been stubbed with new material.

(4) 13.8-Kilovolt Lines. - Three 13.8-kilovolt transmission lines, one to each of the Separation Areas, were constructed in order to provide these areas with permanent electric power. A tap line was run east from the 13.8-kilovolt transmission line for the West Separation Area in order to provide electrical service for the meteorological buildings. A 13.8-kilovolt tap line was run south from the B-Pile Area primary substation to the existing pole line of the Priest Rapids Irrigation District. New wire was strung and poles were replaced wherever needed in revamping this line for 13.8-kilovolt service to the Riverland Classification Yards. A secondary substation was constructed at Riverland, reducing the voltage to 2.3 kilovolts.

(5) 2.3-Kilovolt Line. - A 2.3-kilovolt transmission line approximately 5.9 miles in length, running east and west parallel to the Cold Creek Road, was built in the North Separation Area in order to supply the widely separated portions of that area with permanent electric power. Power for this line is fed through the North Separation Area secondary substation (13.8- to 2.3-kilovolts, 2000-kilovolt-amperes). This line is of single pole, three wire, single cross arm, pin insulator construction, using 35 foot poles and #2/0 stranded copper wire. Service was established approximately one month before required for operations.

7-3. Communications.

a. Telephone Cable and Instruments (See App. B 56). - In

accordance with an agreement reached at a meeting held 17 June 1943 between the Office of the Chief of Engineers, the Office of the Chief Signal Officer, and the du Pont Company, the following work arrangements were adhered to in providing permanent telephone facilities for the Hanford Engineer Works:

1. The Prime Contractor was responsible for the development of requirements, design, and the preparation of all drawings and specifications for the telephone system. All matters were handled in accordance with War Department regulations governing the installation of Government-owned telephone systems. This work was carried out in collaboration with the Office of the Chief Signal Officer. The Signal Corps Plant Engineering Agency of Philadelphia furnished technical assistance when required. Information was furnished by the Signal Corps as to the availability of equipment and materials in order that design could follow.
2. The loading, unloading, and receiving of materials, as well as miscellaneous labor, were performed by the Prime Contractor at the request of the Signal Corps.
3. It was the responsibility of the Ninth Service Command to direct the construction and provide necessary field engineers to do the detailed field engineering work. The Pacific Telephone and Telegraph Company, in accordance with an agreement made with the Ninth Service Command, carried out most of the permanent

telephone construction and installation for the Project. The Signal Corps Plant Engineering Agency obtained and secured all equipment and material that could not be furnished from available stocks of the Ninth Service Command.

4. In November 1943, the Ninth Service Command was to take over the remaining work on the Project. Up to this time the Pacific Telephone and Telegraph Company had completed the original main trunk line system from the southern boundary of the Project to Richland, the Metal Fabrication and Testing Area, Hanford, Central Shops, East and West Separation Areas, and Pile Areas and had finished approximately

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60 per cent of the distribution lines in the B-Pile Area and the West Separation Area. All instruments were installed by the Signal Corps.

5. The telephone property owned by the five independent companies (See App. B 48) in the area of the Project was acquired by the Government. Acquisition negotiations included allowances for severance damages determined by qualified appraisers and included intangible values that were not directly related to severances. Negotiations with the Washington State Public Service Commission were made by the Signal Corps, to relieve the independent telephone companies of their responsibility to serve the area until that

time when the reservation returns to private ownership.

b. Telegraph. - During the peak of construction, telegraph service consisted of four Western Union printers, two teletypewriter (TWX) machines and associated circuits, one private teletypewriter circuit between Hanford Engineer Works and Wilmington, one direct teletypewriter circuit to the Army Communications Administrative Network, and teletypewriter equipment for sending code messages. In addition to these services, during the construction period, direct teletypewriter service was established in Hanford for the United Press and the Associated Press News Service. These were disconnected in the Spring of 1945, at the conclusion of the construction period. After all construction work had been completed, in order to provide more economical and efficient service, all of these facilities, which formerly had been spread among construction forces, operations forces, and the Area Engineer, were consolidated under the direct control and operation of the Area Engineer. The services were then cut down to one Western Union printer, one direct connection to the Army Communications Administrative Network, and a coding machine.

c. Radio. - Because of the areas involved and the widely separated locations of the plants, it was considered essential to equip isolated patrol stations, patrol cars, and patrol planes with two-way radio communication. Sufficient transmission and receiving equipment was requisitioned from the Signal Corps to fulfill the requirements.

7-4. Roads and Railroads. - At the time the site for the Hanford Engineer Works was chosen, only meager road and railroad facilities

existed in the vicinity of the area (See App. A 9). These were insufficient to handle the heavy traffic demands of the Project, and new facilities had to be provided, in addition to improving the existing systems. The greater portion of plant roads and railroads was built by subcontractors; off-area railroad facilities were not acquired by the Government and were improved by the owners.

a. Preliminary Work. - Inter-area and intra-area railroads and roads were laid out from the plant-wide coordinate system except for the intra-area roads in the Metal Fabrication and Testing Area and Richland Village, which were established from the Richland coordinate system. Preliminary surveys for inter-area railroad and road layouts were made by profile and cross section method over routes suggested by the Prime Contractor's Wilmington Design Division. For these surveys, preliminary alignment and grades were set by the field and submitted to the Wilmington office for approval. The alignment of grades of existing plant railroads and roads were used wherever possible to reduce the amount of grading. Preliminary surveys were started during the middle of April 1943 and were essentially complete by the end of August 1943.

b. Permanent Construction Work. -

(1) Roads (See App. A 7, 130). - The permanent road system serving the Hanford Engineer Works has an over-all length of approximately 291 miles, without regard to classification, width or type of surface. This total does not include approximately 50 miles of roads and streets in Richland Village. The plant roads are a combination of new road construction, existing roads improved and maintained,

existing roads maintained only, and existing trails improved and maintained (See App. B 49). On gravel subgrades, the gravel was removed for a depth of at least five inches and refilled with a three-inch minus gravel stabilized with water. Road construction during the summer months required approximately 500,000 gallons of water per mile, for a 28-foot minimum subgrade, in order to compact road bases properly. Most of the road construction was over gently rolling terrain which minimized grading. However, a maximum cut of 38 feet and a fill of 48 inches was required on the section known as Road "A" which runs between the Cold Creek and Allard Road. Grades on this section reached a maximum of six per cent. Wyes, using 16-degree simple curves, were built at all main intersections to reduce traffic hazards. All main roads were center-lined and had posts set along fills and embankments. The major part of the road construction was performed by two separate subcontractors: Meyer Brothers, W. M. Ball Sons, under the original road contract; and Guerin Brothers (See App. B 4). A number of secondary roads, such as approaches to areas, were built by the Prime Contractor. Definite sequence schedules were established in the construction of all roads. The work covered in the original road contract was essentially complete by the middle of December 1943. Work by Guerin Brothers was not started until the following spring, allowing the final surfacing and seal coats to be applied during the summer months. Most of the bases for the intra-area roads were built under the original road subcontract, with the surfacing in the B- and D-Pile Areas and the West Separation Area, as well as 80 per cent of the surfacing in the East Separation Area, laid by the secondary road subcontractor. The road

bases in the Metal Fabrication and Testing Area were prepared and surfaced entirely by the Prime Contractor. The roads in the Administration Area were built by the Smith-Hoffman and Wright Company, who also hold the subcontract for the construction of the roads and streets in Richland Village (See App. B 4).

(2) Railroads. - The permanent plant railroad system, serving all areas of the Hanford Engineer Works, consists of approximately 125 miles of standard gauge single track. This total includes 28 miles of reconditioned track of the former Chicago, Milwaukee, St. Paul and Pacific Railroad line (See Par. 9-3), and 5.4 miles of temporary track left in place at the request of the Contractor's Operating Department at the close of construction. A number of temporary tracks at the Riverland Classification Yards and between White Bluffs and Hanford could not be removed prior to the completion of the Pile and Separation Areas since they were required for the shipment of excess construction materials and equipment. The majority of the plant railroad tracks are located in the northern part of the Project to provide for the transportation of chemicals, raw materials, fuel, and equipment to the Pile and Separation Areas (Service Tracks) and for the transfer of partially-processed product from the Pile to the Separation Areas (Process Tracks). The tracks in the Metal Fabrication and Testing Area, the Administration Area, and Richland Village are all classified as Service Track (See Vol. 3). The Guy F. Atkinson Company was awarded a subcontract for the construction of the permanent plant railroad system (See App. B 4). Only a minimum amount of clearing and grubbing, consisting mostly of removal of sagebrush, was required before grading

could be started. Rock excavation was required for tracks through the Butte Section, which lies between the B-Pile Area and the West Separation Area. Since most of the grading was done in the dry summer months, water was used by the railroad subcontractor to help compact the road bed. Eighteen water trucks, hauling a combined total averaging 550,000 gallons per day, were used throughout the major part of construction. On the Richland-Hanford line the track crosses marshy land; therefore, a one-inch layer of sand was used as a base course for the railroad fill in this section in order to begin construction before this area could be properly ditched and drained. Native gravel was used for the balance of the fill. Two aggregate pits, provided with screening and crushing facilities, were opened at approved locations by the Newport-Kern and Kibbee Co., ballast subcontractor for the Guy F. Atkinson Company. Ballast Plant No. 1 was centrally located in respect to the Pile and Separation Areas, thereby providing a greater portion of the ballast for the railroads in that section. Ballast Plant No. 2 was located one and one-half miles west of Hanford. The latter plant was opened primarily to furnish ballast for the Hanford-Richland line. The Prime Contractor provided electrical power service and extended necessary rail facilities to the above locations.

Immediately upon acquisition of the existing trackage, maintenance of the railroad track started and was expanded to meet the needs of the 126-mile total, including such work as ballasting, removal of sand, and lifting, aligning, and replacing ties, rails, and plank crossings. Rolling stock maintenance facilities were provided at Riverland Yards where a locomotive house was located; this building had reinforced

concrete foundations, floors, and pits under the tracks, drop-siding over sheathing walls, built-up felt and gravel surface roofing, presdwood ceilings and partitions for offices, overhead track doors, and a center portion of post and girder construction. All rolling stock used on the Project was standard gauge (See App. B 56, ~~p.~~).

SECTION 8 - CONSTRUCTION OF RICHLAND VILLAGE

8-1. General. - Because of the isolated location of the Hanford Engineer Works site and the lack of available housing in the few neighboring communities, it was necessary to include in the construction program a village for the housing of the employees who would operate the plant. Richland Village was constructed to house and supply commercial facilities for a maximum of 17,500 persons. The administrative facilities for the entire plant were constructed within the limits of Richland Village.

8-2. Richland Village (See App. A 26, A 131, and B 56). - Because the Prime Contractor's Design Division in Wilmington was actively engaged in work on the process areas of the Hanford Engineer Works and on other war plants, the job of detailed planning of the village layout and the design of the living quarters and commercial buildings was subcontracted to O. A. Fehrson, a resident architect-engineer from the Northwest (See App. B 4).

a. Preliminary Work.

(1) Layout. - In order to expedite the design and planning of Richland Village, no attempt was made to apply the plant coordinate system to the Village (See App. A 18), the Richland system being established before the plant system was completed. Layout work in Richland was inaugurated on 20 March 1943, when field work for preliminary topographic surveys and the preparation of topographic maps was begun. All preliminary work was handled by the subcontractor and was completed in approximately two weeks.

(2) Temporary Construction. - Practically all of the work was performed under contract and the number of temporary construction facilities required by the Area Engineer's and the Prime Contractor's forces was kept to a minimum. Temporary facilities had to be provided for other than construction purposes, such as living quarters for firemen and patrolmen, gas stations, and a ration office (See App. B 60).

b. Progress of Construction. - Because the housing facilities which were to be provided in Richland were needed urgently, every effort was made to get construction under way to complete a large number of residences as soon as possible. It should be noted that, from virtually a barren land, a town to accommodate approximately 17,500 people was constructed in less than two years (See App. B 51).

c. Construction Delays. - Throughout the construction of Richland various difficulties and delaying factors were encountered. Most of these were due to war-time conditions, but the remoteness of the Project, and the size of the village required to house the workers, were also contributing factors.

(1) Design. - It was imperative that construction of the village get under way as soon as possible because a portion of Richland was to be made available for construction personnel. This, coupled with the fact that it was impossible in the beginning to determine the size of the operating force required, and what portion of this force could be housed in surrounding communities, made the early planning of the village quite difficult. The first estimate on the

size of the village anticipated a population of 6500 persons; the final estimate was approximately 17,500 persons.

(2) Labor. - Although the major portion of the work in Richland was subcontracted, the supply of labor available proved to be a serious difficulty throughout the construction period. At times the labor scarcity became so critical that it was necessary for the Prime Contractor to supply workers to the subcontractors, particularly in the case of painters and electricians.

(3) Existing Buildings and Facilities. - In the layout and planning of Richland every effort, insofar as was possible, was made to save all buildings, orchards, shade trees, roads and streets, and other decorative or utilitarian facilities which would be of benefit to the permanent village. This handicapped construction. In view of the fact that portions of the village were occupied from the beginning, the existing water, power, and service facilities could not be molested until new utilities had been provided. Houses were placed in the midst of orchards making it necessary to plan the construction of each house so as not to disturb the trees.

d. Construction Expedients. - Wherever possible attempts were made to employ expedients in the construction of Richland. Most of these expedients were not unusual, but could be considered simply good construction practices. However, some noteworthy expedients were employed.

(1) Subcontractors. - In view of the specific type of work involved in the design of a village, it was considered advisable to employ a competent architect-engineer familiar with

local conditions. For the actual construction of the village three major subcontractors, familiar with this type of work, were selected (See App. B 4). The first subcontractor (Twaits-Morrison-Knudsen) constructed 290 duplex houses, or 580 units, and the utilities in the northern portion of the village, as well as the Cafeteria. The second major subcontractor (Smith, Hoffman, and Wright) handled the construction of the remainder of the conventional type houses and most commercial and service buildings and facilities in the village. The third major subcontract was placed directly by the Area Engineer with the Prefabrication Engineering Company of Portland, Oregon, for the construction and erection of the prefabricated houses. The construction of foundations and utilities for the prefabricated houses was subcontracted to Smith, Hoffman, and Wright by the Prime Contractor.

(2) Material. - To protect the contemplated construction program, realizing that the lack of an adequate available supply of lumber would add to difficulties encountered in construction, the Prime Contractor purchased quantities of lumber (in assorted sizes) prior to the start of construction. Although the sizes did not all coincide with those of the lumber needed, as purchases were made in advance of the issuance of drawings, eventually all this material was used on the Project. While designs of the various buildings and facilities were based upon using as little of the more critical materials as possible, unforeseen scarcities of particular items were encountered and substitutions were necessary. The cases requiring substitutions were not significant in view of the size of the village and the quantities of materials involved.

(3) Special Construction Methods. - In the construction of the prefabricated houses, the methods used were most unusual. All of these houses arrived in sections approximately 8 feet wide by 20 feet long; the one-bedroom house was composed of two sections, the two-bedroom house of three sections, and the three-bedroom house of four sections. These sections were constructed by the Prefabrication Engineering Company at a factory in Toledo, Oregon, and were hauled to the Project, where they were placed on the foundations, fastened together, and then anchored. Prior to the arrival of the house sections on the Project site, various sections were routed to a furniture factory in Portland, Oregon, where the items of furniture, including cabinets, were placed within. Thus, some of the sections were used as packing cases, or boxes, for the furniture. When these sections arrived on the Project, the furniture was distributed to the houses as required.

8-3. Administration Area (See App. A 27, A 132, and B 56). - The Administration (700) Area is located in Richland Village, and all buildings, with a few exceptions, are of wood frame construction. The telephone exchange, power house and water softening plant were of concrete, concrete block, and brick construction. Fourteen sheet metal hutments were used in this area.

a. Preliminary Work.

(1) Layout. - The Administration Area was considered as a portion of Richland and was included in the coordinate system established for Richland (See App. A 18). The first permanent building, the Heating Plant, was staked out on approximately 1 September

1943, and the last, Permanent Record Storage, on 1 December 1944.

(2) Temporary Construction. - The construction of this area was handled almost entirely by subcontractors. The number of temporary construction facilities required by the Prime Contractor or the Government was kept to a minimum. The temporary facilities established were used for both Richland and the Administration Area (See App. B 50).

b. Progress of Construction. - Since the Administration Area contains no process buildings or process facilities, the process areas were given preferential consideration in the construction of the Project (See App. B 52).

c. Construction Delays. - Various difficulties and delaying factors were encountered during the construction of the Administration Area. Generally these difficulties were the same as those encountered in the construction of the village, inasmuch as this area was constructed concurrently with, and as a part of, the village.

(1) Design. - The design of the Administration Area did not become stabilized until the fall of 1944. Prior to that time, various design changes and additions were made, and most changes concerned the addition of entire new structures rather than changes to structures on which construction had already started. The completed area contains almost twice as many buildings as originally called for. Design for this area was supplied by the Prime Contractor.

(2) Restricted Area Work. - To restrict the completed portions of the area to production personnel only, a "special permit" procedure was inaugurated in the spring of 1944. This procedure made

[redacted]

it necessary for any construction employee entering the Administration Area to obtain a permit tag, which was issued by the Operating Department upon specific request of construction supervision in the area. In addition to the "special permit" procedure, temporary fences were constructed in the area to segregate completed buildings from those under construction and, as additional buildings were completed, the fence was extended to include them.

d. Subcontracts. - In view of the fact that Richland Village was constructed by subcontractors familiar with that type of work, it was considered advisable to have the construction work in the Administration Area performed by the same subcontractors. The major portion of the construction work in this area was performed by the Smith, Hoffman, and Wright Company. Small portions of work, such as the construction of the boilers and steel work in the Heating Plant, were done by other subcontractors. The outside electrical and pipe work in the area was handled almost entirely by the Prime Contractor and his fixed-fee subcontractors.

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SECTION 9 - TRANSPORTATION

9-1. General. - The necessary isolation of the site from large centers of population, public roads, and main line railroads presented a problem in supplying all forms of transportation. Many improvements in the meager existing facilities were required and new provisions had to be made for the large-scale transportation of equipment, material, and personnel. The Area Engineer's Transportation Department was organized 15 March 1943, to maintain, schedule, dispatch, and operate all transportation equipment, with the exception of railroad equipment, the latter being operated by the Prime Contractor. All buses used in the transportation of personnel in the Hanford Engineer Works were supplied by the Transportation Corps of the Army and were operated under rules of that service.

9-2. Existing Facilities. - A spur line of the Chicago, Milwaukee, St. Paul and Pacific Railroad at Beverly Junction, Washington, extending to Hanford, Washington, was in service (See Par. 7-4). This line was old, had light rail, and a large number of trestles and bridges, and for some 18 miles skirted the Columbia River along bluffs and talus slopes, on fill and bench-graded roadbed. Washington State Highway 11-A ran west from Hanford to Yakima and northeast from Hanford to Spokane (See App. A & B). With a road running from Richland to the horn of the Yakima River, then north to Hanford, the road axis available permitted access to the important areas. These existing routes, while not first-grade roads, greatly expedited the initial construction operations at the Project site. They were, of course,

inadequate for the entire plant service and additional facilities had to be provided. Existing routes and existing roadbeds were utilized, contributing to some extent to the determination of plant layout. To provide the maximum advantage to construction operations, action was initiated early in the program to build service roads and railroads at the earliest possible time.

9-3. Railroads. - The rail facilities were considered as a possible means of transporting personnel, but the lack of available equipment, and the lack of operating flexibility in a railroad system designed for industrial service, made it impracticable. The use of the railroad, therefore, was confined to movements of freight, construction materials on an inter-plant movement, and incoming shipments of supplies and equipment. As the available access by rail to the Project was over the spur line from Beverly Junction, a line in which many operating hazards were inherent, study was given immediately to another connection with the Northern Pacific Railroad (See App. A 28), and the Union Pacific Railroad lines near Kennewick. This connection would have provided an alternate access to the plant railroad system and would have provided more direct rail access from the Wyoming, Utah, Southern Montana, and the Southern Middle West areas than was available from the Chicago, Milwaukee, St. Paul and Pacific Railroad at Beverly Junction. However, after much discussion and after developing complete plans and details for the connection it was decided by the Area Engineer that the connection would not be required, if the Chicago, Milwaukee, St. Paul and Pacific Railroad would so improve their access line as to provide reasonable assurance of uninterrupted

service. The Chicago, Milwaukee, St. Paul and Pacific Railroad agreed to do this, and a large amount of work was done by them in placing fill material to strengthen a long, high trestle at the main line junction, widening the subgrade, both in cut and fill sections, reinforcing curves, putting in heavier rails on curves, and maintaining abnormally large track maintenance crews on this spur line at all times. Practically all of the concrete aggregates for the Project were produced from two pits near the existing railroad, and the railroad service was extended to these pits to transport this material to the mixing plants in the various construction areas. Although the railroad haul was the most economical method of handling the material, it placed a heavy load on the railroad system during the same period when large shipments of construction materials, equipment, and other supplies were being shipped in. During the construction period, approximately 40,000 carloads of material were shipped into the Project over a period of about 22 months.

9-4. Water-Transportation. - Very little transportation service was offered to the Project by boat or barge. The principal commodities received by barge were oil and gasoline, some of which was delivered to Umatilla, Oregon, on the Columbia River and hauled from there by truck to the Project, a distance of approximately 60 miles. The Columbia River is not considered navigable above Pasco and the terminal facilities available at Umatilla were the only ones anywhere near the Project that were adequate to serve the handling of oil and gasoline.

9-5. Air Transportation. - Because of the close scheduling and

rapid construction required to complete this plant at the earliest possible date, and the fact that much of the design was only slightly ahead of construction, equipment and materials of a seriously critical nature had to moved to the area faster than by normal freight. Arrangements were made with the Air Transport Command to bring in critical items, such as chemicals, replacement parts for construction equipment, and parts of process equipment upon which start-up depended, that had to be received on the job immediately to avoid delays in construction progress. Items for which an early delivery was imperative and of which freight shipments would have caused construction delays were shipped by express. In all cases, a careful study was made to insure that this material, if delivered by these faster means, would actually avoid serious handicap to the job and delay of completion. With the assistance and cooperation of the Army Air Corps, Air Transport shipments were made to the Project by means of an air shuttle service from Spokane, the nearest Air Transport terminal, to the Hanford airport, when weather conditions permitted.

9-6. Area Bus Service (See App. B 55). - The general location and layout of the plant areas having been established, an early consideration affecting transportation needs for construction involved the decision to operate from one principal construction camp at Hanford as contrasted to establishing a construction camp in each of the major plant areas (See Par. 5-2). Considerations of economy of operations, the value of central control, and the compelling need for immediate action in getting construction started indicated that

it would be better to provide transportation from a central point to serve all of the construction areas. With Hanford designated as the camp site, the problem of transportation of workmen to and from their jobs became a fairly definite one and considerable study was made to determine a bus transportation system which would serve construction personnel at the minimum cost and with the least use of service personnel. The long distances between facilities both in Hanford Camp and in Richland, together with rationing limitations on gasoline and tires, made it necessary to establish local bus service during the construction period. No charge was made for local shuttle service at Hanford, on the basis that the persons there who were assigned a place to live could not be expected to pay for transportation to central facilities and to their work, inasmuch as they received no pay for time spent in transit between Hanford and the job. The peak in bus use for this Project was reached in September of 1944, at which time 904 buses were in use. This was considered the largest bus operation in the world for any given territory or city, the nearest in size being in the city of Chicago, numbering about 800 buses. The remarkable part of this bus operation was shown by a survey made in August of 1944 which showed that only 1/5 of 1 per cent of the total number of buses were not in use, and these were idle because of mechanical breakdown. A total of 20 million passengers were handled and approximately 340 million passenger miles were travelled between the period of 1 April 1943 and 1 March 1945.

9-7. Off-Area Bus Service. - The necessary isolation of the Project area, and the fact that the nearby communities were small,

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meant that a comparatively small persentage of the total working population of the Project could be housed off the Project. However, the adjoining towns, such as Pasco, Prosser, Kennewick, Sunnyside, Yakima, and other towns surrounding the Project did absorb a capacity load of working personnel, and transportation facilities had to be provided to get them to and from work (See App. B 53). Commercial operators were approached with the idea of providing bus service from these towns to Hanford or some other central point from which the plant bus system could move personnel, but these efforts were only partially successful. Commercial operations were established between Yakima and Hanford, and between Pasco and Hanford. Project-operated buses connected Sunnyside, Prosser, and other small communities in the area to the Project site. The restrictions on use of gasoline in private cars made this service absolutely necessary, although some personnel continued to drive on a pool system in their own private vehicles. On-plant transportation for working personnel going to and from work was provided free of charge. However, where the route left the Project, a charge was set up to cover the distance operated off the Project. For personal use, the commercial buses to Yakima and to Pasco from Hanford were available with appropriate charges made for this service.

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SECTION 10 - SAFETY

10-1. General. - The safety program for the Hanford Engineer Works was considered an essential part of the program for the successful completion of the construction phase of the Project. Important to the progress of the work and to its performance in an efficient manner and at the lowest possible cost was the maximum use of available manpower by the prevention of accidents through an organized safety program. In addition to the direct benefits which accrue from such a program, there are such further benefits as the improvement of employee morale, lowered labor turnover, and a reduction of absenteeism. A reputation for few serious accidents is also a great assistance in the recruitment of personnel. Further details of the Manhattan District's Safety Program can be found in Book I, Volume 11.

10-2. Operation. - The Manhattan District was so extended in size that close supervision by the District was impossible, and a unit, as nearly complete as possible, was organized by the Area Engineer so that it would be able to function within itself. Reports on man-hour exposure, accidents, new procedures, and prevailing working conditions were submitted to the District Engineer's Office. The U. S. Engineer Safety Division functioned in a supervisory capacity at all times. The Contractor's safety program was organized and operated under the supervision of the Engineer's Safety Division. All problems of procedure dealing with safety were discussed between the Contractor's Department and the Engineer's Department. Items of major importance were routed to the Area Engineer for consideration and recirculated to the

Contractor.

10-3. Organization. - The Area Engineer's Safety Division consisted of various sections headed by personnel particularly qualified in that field of operation. The various sections were as follows:

a. Construction. - The Construction Section was obligated to supervise and advise the Contractor on all phases of construction and engineering where hazards to the workman were involved, including proper design, placement, and movement to the site of materials for construction.

b. Traffic. - The Traffic Section dealt with proper movement of all vehicle transportation, such as proper mechanical equipment, loading and unloading zones for passengers, parking lots, traffic channelization, zoning of pedestrian traffic, and vehicle accident investigation. The National Safety Council Traffic Department assisted in layout design for both Hanford and Richland. The school patrol was organized by the Traffic Section.

c. Community. - The Community Section inspected all food items and all buildings dealing with the dispensing or storage of food. This group made routine inspections of drinking water, dairies, meat plants, grocery stores, barracks, sewage disposal units, garbage disposal units, and public entertainment centers. This section was also responsible for the propagation of an active and effective children's training program.

d. Fire Protection and Prevention.

(1) Fire Protection. - This section dealt with the procurement of fire fighting equipment and personnel, the maintenance of

equipment, and the training of men. The section organized evacuation procedure in event of fire.

(2) Fire Prevention. - This section established methods of fire prevention, which included inspection of all buildings and areas, and concentrated publicity methods to emphasize the need for fire prevention. Assistance was rendered to the Fire Protection Section in the checking of equipment, such as fire extinguishers and masks.

10-4. Education and Promotion. - In order to consolidate construction safety promotion, a safety education group, consisting of a safety engineer, an advertising layout man, artists, and sign painters, was organized. Library and consultant service for group leaders was provided. Various safety campaigns were planned; safety literature on check inserts, time cards, and stationery forms was prepared; and safety posters were produced for use on the Project.

a. Meetings. - One method that proved successful in promoting safety education was the organization of safety meetings, at which problems were discussed, explained, and illustrated (See App. B 54).

b. Printed Material. - For security reasons, the printed safety material was general in nature, and hazard forecasting was presented orally by the Division Safety Engineers in weekly planning meetings. Standard education material, including a book of twenty-two Safety Standards and several mimeographed instruction sheets, was prepared for distribution among the crafts. On 22 July 1943, a Plant Safety Information Sheet was published and distributed for the purpose of giving construction foremen materials for discussions at the safety

meetings. An illustrated Safety Handbook was prepared and this indicated, by means of actual photographs, the basic safety practices.

c. Statistical Group. - To apply quality control to injury performance, and to furnish information to crafts and areas on safety compliance, a Safety Statistical Group was formed in April 1944. A system (utilizing a standard check sheet) was devised for checking and measuring the safety compliance of the crafts and areas throughout construction. This department also handled minor injury reports, prepared charts, and tabulated the injuries by crafts from the First Aid Log Sheets.

d. Activities. - In order to impress each individual at Hanford with the importance of safety on the job a number of contests and programs were promoted (See App. B 14). A suggestion contest, a citation plan, a safety exposition, and a safety award program highlighted these activities.

10-8. Safety Equipment. - The use of safety equipment was very necessary to the efficient working of the safety program. Wherever possible, the employment of such equipment was enforced and every effort was made to educate all construction workers in its use.

a. Vended Equipment. - A Safety Shoe and Glove Store was opened in Hanford on 18 May 1943 by the Contractor's Receiving and Stores Department. To accomodate workers in the field, a specially equipped safety-shoe truck made scheduled trips to the various areas. Other safety equipment was distributed through the central tool room at Hanford, and through the area tool rooms. On 24 August 1944, the Central Safety Section was given control of personal protective

equipment. A central warehouse was located in Hanford where equipment was stocked and issued. A supervisor, experienced in Safety Engineering, directed the crew which serviced this equipment in the various areas. Daily checks on inventories and contacts with the Safety Superintendent and Area Safety Engineers insured an efficient control of equipment and an early knowledge of anticipated requirements.

b. Issued Equipment. - Gloves and goggles were issued free of charge to new field employees at the close of their orientation meeting. Craftsmen engaged on work in connection with machinery, or the handling and erection of certain materials in the Special Fabrication Shops, were furnished coveralls, gloves, and safety shoes, with no cost to the worker. Those employees who had been issued prescription safety glasses were allowed to retain them at the time of termination, if they so desired, by paying a fee of two dollars.

10-6. Safety Consideration for Women. - Because of the number of women on the Project, and because it was felt that a woman would have a better understanding of these employees, a qualified female safety engineer was assigned to the Safety Department in April 1944. Her duties included the compilation of material for a training program for safety engineers, the inspection of general offices, the organization of Office Safety job analyses of all work performed by women, other than general clerical work.

10-7. Results. - The sole purpose and aim of the Safety Program of the Hanford Engineer Works was the elimination of hazardous conditions due to work and living conditions. That this was done in a highly effective manner is apparent from the results obtained (See App.

B 55).

a. Construction. - The construction safety program was successful in every phase. The total job frequency was 5.79, meaning five and seventy-nine hundredths accidents per million hours worked. This frequency is well below the national average for construction, which shows 126 deaths per 100,000 workers, or approximately "one death per 1,900,000 man-hours worked." There was a total of twenty fatalities on the construction phase of this Project, which leaves the Hanford Project a little over fifty to go.

b. Community. - The community program was successful. There were no epidemics of any size. Although the program could not check the so-called "Termination Powder" (See Par. 4-4), efforts were made to keep living and eating quarters in a sanitary condition.

c. Traffic. - The traffic program speaks for itself in that not one single accident due to collision was experienced in the town of Hanford during construction. The traffic accidents for vehicles on the Project were very low. This went a long way in the national program for conservation of motor vehicles of all types.

d. Fire Prevention. - The fire prevention and protection program functioned very satisfactorily. No major fires were experienced on the Project at any time. The minor fires were held to a minimum.

e. Comparisons.

1. The "Frequency Rate," or rate of occurence of lost-time accidents per million hours worked, was only 40 per cent of the experience of other construction work throughout the United States.

2. The "Severity Rate," or the rate of experiencing "lost-days" due to accidents for each 1000 hours worked, was only 57 per cent of the experience of other construction work throughout the United States.

3. The cost of all accident prevention methods was kept at a fraction of 1 per cent of the payroll.

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SECTION 11 - COSTS

11-1. General. - The total cost of the construction of the Hanford Engineer Works as of 31 December 1946 was $348,101,240. The construction cost, in accordance with the standard accounting practice of the Contractor, includes all materials to equip the Plant for the start-up of manufacturing operations and reflects the application against specific costs of whatever salvage credits have been realized to that date. Most salvage which occurred during active construction was immediately assimilated by current construction needs, while the salvageable material on hand after active construction was, for the most part, transferred to other government agencies without reimbursement; for the latter, which amounted to approximately $28,044,301, cost credits were applied against appropriate building and cost codes.

11-2. Accounting Methods. - Detailed costs were maintained by the Prime Contractor in accordance with his regular method of cost keeping on construction projects, with certain modifications to comply with general accounting methods of the Corps of Engineers. A modified form of procedure was used by the Area Engineer's forces in maintaining a Control Account of Prime Contract Cost and detail records of Government Overhead and Maintenance Accounts. Cost of materials, equipment, and supplies furnished by the Government on both a free issue and procurement basis were supplied the Contractor and incorporated in the features of work by direct allocation and/or stores distribution. Labor charges were allocated direct to features of work by the Contractor on the basis of individual time cards. Main

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subcontract labor charges were also distributed on a time card basis. Materials and equipment were allocated to features of work where purchased specifically for a feature and on the basis of store tickets on items of a general nature, such as lumber and nails. Distribution of main subcontractor's material and equipment costs was also made on this basis. In addition to the above-mentioned main subcontracts, several subcontracts were let covering specific codes, and charges covering labor, material, and equipment were, therefore, allocated to the specific code involved on the basis of reimbursements to the subcontractor. Major construction equipment maintenance, shop equipment maintenance, small tool maintenance, and miscellaneous clearing costs were distributed periodically, on the basis of total labor charges, to construction features during the period involved. Overhead and deferred accounts were distributed at the close of construction on the following basis:

1. Engineering Design: village design to Richland Village (1100 Area), plant design to the various plant features on the basis of total labor and material cost.
2. Engineering supervision, home office expense, field supervision, field expense, transfer-out expense, Government overhead, and similar accounts were distributed to all features on the basis of total labor and material cost.
3. Temporary construction charges were distributed to the feature of work for whose benefit the

particular work was incurred.

4. Major equipment, rented equipment, and small tool charges were distributed to all features of work except the Administration Area and Richland Village. No distribution was made to these accounts since all work was done by subcontract.

5. Equipment charges incurred at the Hanford Camp and under general commercial facilities at Hanford were distributed to all features of work except the Administration Area and Richland Village. No distributions were made to these two areas since subcontractor's employees were quartered in the subcontractor's camp and did not receive any benefit from the Hanford Camp or Hanford commercial facilities.

6. Government overhead and clearing accounts were distributed to all accounts on the basis of total labor and material.

11-5. Cost Summary. - Construction costs for the Hanford Engineer Works (See App. B 56) are divided into three main categories: Main Plant, Richland Village, and Special Construction Features.

a. Main Plant. - The total construction cost of the Main Plant was $255,517,191. This cost includes $48,345,842 for outside facilities, such as electric lines, steam lines, water lines, roads, railroads, and fences; $200,231,785 for Plant buildings and equipment; and $3,939,564 for the general Administrative Area and Maintenance

facilities (buildings and equipment).

b. Richland Village. - Construction costs for Richland Village were $45,074,398. Of this total, $28,741,607 was used for the construction of living quarters (conventional type houses, prefabricated houses, and dormitories); $8,808,452 for the construction of commercial buildings (all facilities on which operation is leased out by the Government); $4,145,238 for construction of public buildings, such as schools, churches, etc.; $3,844,051 for construction of roads, streets, and grounds; and $9,459,047 for construction of utilities, such as sewer, and water systems.

c. Special Construction Features. - The cost of special construction features for the Hanford Engineer Works was $50,908,657. Of this total, expenditures were as follows:

(1)	Hanford Camp	$37,688,302
(2)	Central Shops	1,070,060
(3)	Construction, Administrative and Service Facilities	2,297,083
(4)	Special Fabrication Area (TC-101)	1,251,023
(5)	3000 Area Barracks	498,308
(6)	Utilities and Public Facilities	7,256,418
(7)	Maintenance of Farm Lands during Construction	856,313
(8)	Miscellaneous Special Construction	96,170

SECTION 12 - ORGANIZATION AND PERSONNEL

12-1. General. - Construction of the Hanford Engineer Works was accomplished by two organizations, one reporting to the Hanford Area Engineer, representing the military and civilian personnel of the Manhattan District; the other reporting to a Field Project Manager, representing the forces of the Prime Contractor.

12-2. Area Engineer's Organization (See App. B 57 and B 57a). - It was necessary to form this organization, in its entirety, on the site. This was done by transferring military and civilian personnel from other construction projects. However, it was necessary to supplement these transfers by recruiting from any sources possible, and the personnel thus obtained were not, in many cases, trained construction personnel. As of 1 August 1944, a date near the period of peak construction activity, the Office of the Area Engineer employed a total of 519 persons (187 military and 332 civilian personnel). The Hanford Area Engineer reported to the District Engineer, Manhattan District, Oak Ridge, Tennessee, who reported to Major General L. R. Groves, Commanding General of the Manhattan District.

a. Military Personnel. - The construction of the Hanford Engineer Works was directed by Colonel F. T. Matthias, the Area Engineer. Lieutenant Colonel H. R. Kadlec served as Deputy Area Engineer and Chief of Construction during the major part of construction. Following his death on 2 July 1944, Lieutenant Colonel B. T. Rogers was named as his successor. Major R. F. Ebbs, Executive Officer; Major R. I. Newcomb, Labor Relations Officer; Captain M. K. Barrett, Chief

of Fiscal Division; and Major R. F. Gornall, Survey Officer, served on the Area Engineer's staff. Major H. D. Riley was the Chief of Services, assisted by Captain J. S. Barrish. The Chief of Production was Major J. F. Sally. Captain P. B. Mountjoy served as Intelligence Officer from July 1943 to March 1944 when he was succeeded by Major F. M. Gillette who was succeeded by Captain L. Johnson in November 1944.

b. Civilian Personnel. - The following civilians occupied key positions in the Office of the Area Engineer during construction: J. E. Schmeidel and C. H. Shepherd, special assistants to the Chief of Construction for structural and electrical engineering; O. S. Clark and H. A. Carlberg, high voltage electrical transmission engineers; C. O. Henning, Chief of Engineering; G. F. Meier, Chief of the Legal Division; N. D. Sturgis, Administrative Assistant; and H. C. Hagemann, Technical Assistant to the Chief of Production for all phases of process engineering (during the last half of the construction period).

12-3. Prime Contractor's Organization (See App. B 58). - The construction of the Hanford Engineer Works was under the direction of the Engineering Department of the du Pont Company with E. G. Ackart as Chief Engineer and G. M. Read as Assistant Chief Engineer. The General Manager of the Construction Division was M. F. Wood and F. H. Mackie was Manager of War Construction. The Prime Contractor's field organization was headed by a Field Project Manager who reported to the Construction Division in Wilmington, Delaware, which in turn reported to the Engineering Department. The number of construction workers employed by the Prime Contractor on the Hanford Project fluctuated considerably during the construction period, reaching a peak of approximately 28,000 persons

in June 1944. During the height of the construction period the Field Project Manager, G. P. Church, was assisted by six Assistant Field Project Managers, T. L. Pierce, F. H. McDonald, C. E. Hillman, J. E. Bubb, C. H. Trask, and W. V. Krewatch, who were responsible for the various engineering and administrative divisions of the Prime Contractor's field organization. In addition to the representatives of the Prime Contractor reporting to the Field Project Manager, there were four divisions: Audit, under H. E. Werner; Accounting, under T. W. Brown; Design, under H. T. Daniels; and Traffic, under C. S. Simpson, that reported directly to the du Pont Wilmington Office. Because of the magnitude and importance of the Hanford Project, the Prime Contractor assigned approximately 90 per cent of his expanded wartime construction organization to the Hanford Engineer Works.

12-4. Coordination. - The Area Engineer, Hanford Engineer Works, in his capacity as a representative of the interests of the owner, the Government in this instance, acted in a supervisory and reviewing capacity and did not perform construction activities. The office of the Area Engineer, with its various branches, divisions, and sections, was organized along parallel lines with the Contractor's organization, each section head and division head of the Area Engineer's organization having his direct contact with similar echelons in the organization of the Prime Contractor. The organization of the Area Engineer on construction was divided into two principal sub-divisions, notably Construction and Services. The function of the Construction Branch had to do directly with the prosecution of field construction, the Service Branch had to do entirely with the services necessary to furnish the

needs of field construction.

12-5. Acknowledgments. - In addition to the individuals mentioned above, many others deserve special mention for their contributions to the successful construction of the Hanford Engineer Works. C. M. Gross and K. Millett of the Technical Division of the du Pont Explosives Department TNX Division served as consultants to the Construction forces. S. Sawin, L. Haupt, J. A. Burns, R. P. Genereaux, and G. S. Coffin of the Design Division also served as consultants during construction. R. E. Burton was loaned by the du Pont Company to the Olympic Commissary Company and acted as Field Project Manager. L. J. Harris and H. A. Behling were also loaned to that company and acted as Assistant Field Project Managers. Spenial mention should be made of the services rendered by the Seattle District, Corps of Engineers; Portland District, Corps of Engineers; Headquarters, Ninth Service Command; Signal Corps; the Federal Agencies concerned with housing, rationing, allocations and price ceilings; and other Federal Agencies that contributed to the construction of the Hanford Engineer Works. The following subcontractors performed major jobs during the construction period: Newbery-Chandler-Lord; Hankee-James-Zahniser & Warren; Hanford Concrete Contractors; Smith, Hoffman and Wright; Olympic Commissary Company; and Morrison-Bechtel-McCone.